THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 19 JULY, 1940 Number 7

GORDON BATTELLE

For story, see page 263

A shipload of minerals from Greenland gave the modern ceramic industry its start

EARTHENWARE and tile were known in such ancient times that the birth of ceramics is shrouded in the mists of antiquity. But 1857 is the date when the industry we know today actually received its start. In that year the first shipment of Kryolith was made from Greenland.

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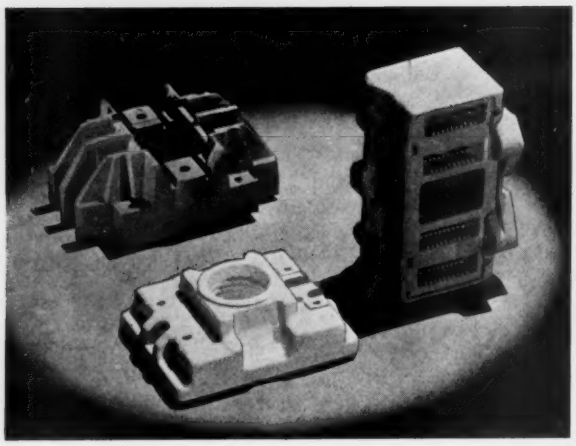

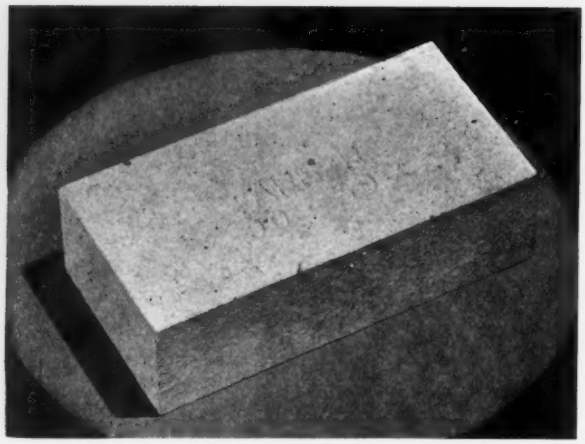

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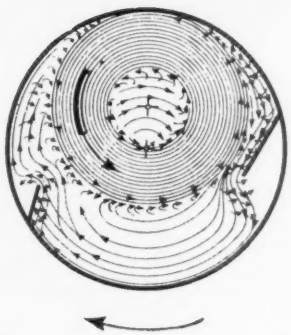

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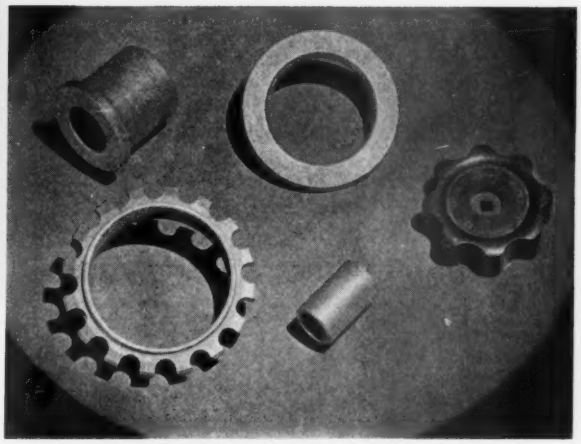

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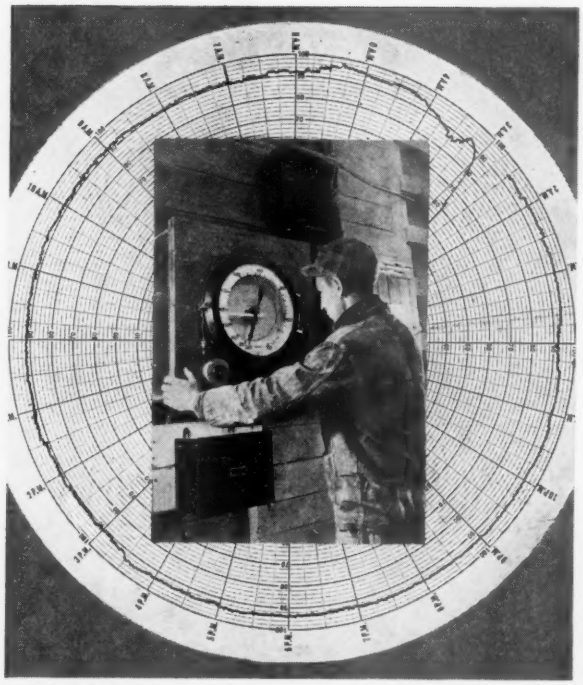

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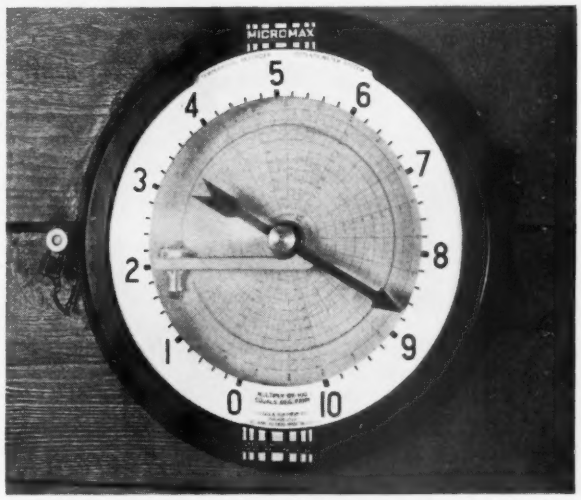

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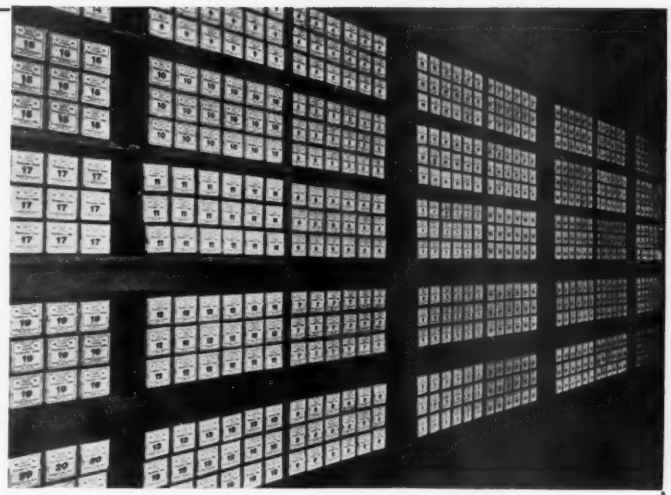

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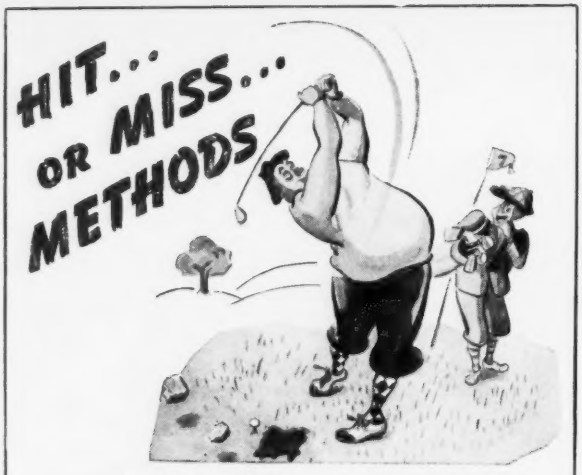

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When this situation became apparent, several leading glass manufacturers naturally turned, for an improved *bottom* material, to the same Corhart* Standard Electrocast which had helped to account for improved performance in other furnace parts. Actually, one or two companies have been using bottoms of 12″ Standard Electrocast since as long ago as 1928—principally on special glasses.

Later, when lime glass tank bottoms began to show comparative weakness, a number of installations were made cautiously in that field. The photograph shows one of these trials. This tank has been operating for the past year with a complete melting-end bottom of Corhart* Standard Electrocast—with an excellent record on glass quality and fuel performance.

The usual fear in regard to entire Corhart* Standard Electrocast bottoms revolves about the question of conductivity. However, experience indicates that this fear is not well founded. The reason is fairly obvious. The Corhart* Standard Electrocast maintains its thickness, while other products, because of their more rapid corrosion, become progressively greater dissipators of heat.

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PAPERS

TOO MANY BRICK SET IN KILN DEFEAT BENEFIT OF LONG FLAME*

By J. G. Seanor

Abstract

For rapid and economical firing in downdraft kilns, furnace gases must be circulated rapidly through the ware. Too much ware set in a kiln will destroy the benefits to be derived from forced-draft furnaces and strong draft on the exhaust flue owing to frictional resistance between furnace gases and ware. Because water, carbon, and sulfur are removed from the ware in the form of gas, the volume of these gases will choke the kiln and will defeat the forced-draft furnaces and high stack draft if too much ware is set in the kiln. Experiments indicate that the height of the setting is more important than the space between the ware.

I. Introduction

Some of the factors are examined that regulate the amount of building brick with which to charge a downdraft kiln. Building brick must be protected from the extreme furnace flame temperatures, and quite commonly the building-brick clays contain carbonaceous material and pyrites, which, until they are oxidized, must be held at oxidizing temperatures before the heat required to mature the brick is advanced.

If the flame temperatures are completely generated in the furnaces, they must be lowered before the furnace gases reach the brick. This may be done in two ways, namely, (1) the high flame temperature may be tempered by mixing cold air with the flame; this cools the flame before it leaves the furnace (this method is expensive), and (2) the flame may be tempered before it comes in contact with the ware by conducting the hot flame into the space between the crown and the top of the setting,[1] using high bag walls (this method is not efficient).

Rather than to develop all of the flame temperature in the furnace, the most efficient and economical method of kiln firing is the employment of long flames,[2] such as those obtained by incomplete combustion in the furnaces.

II. Long Flame Firing

After entering the kiln, incompletely burned gases are slowly mixed with secondary air by diffusion so that final combustion takes place over a long path. This is the metallurgist's "propagation of lazy flame."[3] Brick operators regard this method with suspicion, fearing that it will "flash" their ware, whereas it can actually be an oxidizing flame.[4] By this method, the original flame temperature is comparatively low, but this temperature is maintained well over into the kiln by delayed combustion.

III. Effect of Draft

Much attention is being given to faster methods of firing to reduce production costs. Efforts to shorten firing time often come to grief because of the neglect to take into account the resistance caused by the brick to the flow of gases through the kiln.

* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 19, 1939 (Structural Clay Products Division). Received April 10, 1939.

[1] A. F. Greaves-Walker, data on "bag walls" in Clay Plant Construction and Operation, p. 103. Published by Brick & Clay Record, Chicago, Ill., 1919.

[2] Ellis Lovejoy, chapter on "Fuels and Combustion" in Burning Clay Wares, 2d ed., p. 61. T. A. Randall & Co., Indianapolis, Ind., 1920–1922.

[3] W. Trinks, data on "use of a lazy flame," in chapter on "Control of Furnace Temperature" in Industrial Furnaces, Vol. II, p. 166. John Wiley & Sons, Inc., New York, N. Y., 1925.

[4] (*a*) W. Trinks, data on "oxidation" in chapter on "Heating Capacity of Furnaces" in Industrial Furnaces, Vol. I, 3d ed., pp. 28–29. John Wiley & Sons, Inc., New York, N. Y., 1934. 456 pp.; *Ceram. Abs.*, **14** [2] 47 (1935).

(*b*) W. Trinks, see also chapter on "Control of Furnace Atmosphere," p. 192 of reference 3.

Note: Professor Trinks uses a different terminology from the ceramist: the ceramist's "kiln" is called the "furnace" and the ceramist's "furnace" is a "firebox."

Fast firing in downdraft kilns depends on the rapid flow of gases through the kiln. A tunnel kiln ordinarily will watersmoke, oxidize, and mature face brick in less than forty hours. For example, face brick fired in a tunnel kiln are ordinarily finished and ready to enter the "cooling" zone in less than forty hours. If the speed of firing in a downdraft kiln is to approach that of a tunnel kiln, the flow of gases in the downdraft kiln must be speeded up.

The forces which cause the gases to circulate through a downdraft kiln are the suction of the stack and the "pumping power"[5] of the furnaces. This pumping action[6] is particularly effective at the beginning of the firing period when the stack draft is weak. The "pumping power" is then at its maximum, owing to the great difference between the temperature on top of the bed of coals in the furnaces and that of the atmosphere inside the kiln.[7]

Several years ago it was thought that if the draft were increased, gases could be moved faster and the firing period could be shortened. Increased draft is effective only to a limited degree because when draft is increased beyond a certain point, difficulties with high flame temperatures[8] and with distribution increase rapidly. Forced draft is also effective only to a limited degree, because high flame temperature again develops.

IV. Effect of Brick Setting

Brick in a kiln offer resistance to the passage of gases through the kiln (1) by frictional resistance and (2) by "choking" gases from the ware.

(1) Frictional Resistance

Building brick are often set almost to the crown adjacent to the bag walls. This type of setting acts as a permanently fixed damper. Such an arrangement presents a tight checkerwork so that the furnace gases lose a lot of their velocity by having to pass through a maze of small passages and making frequent right-angle turns. Not only does such an arrangement rob the furnace gases of their velocity, but it sets up a turbulence, which causes premature combustion.[9] If this combustion were delayed until the gases pass over into the kiln, it would aid in heating up the slow parts of the kiln and would also prevent overfiring in front of the bag walls.

[5] W. E. Groume-Grjimailo, "draft fallacy of metallurgical furnaces" in chapter on "Application of Laws of Hydrostatics to Hot Gases" in Flow of Gases in Furnaces, p. 19. John Wiley & Sons, Inc., New York, N. Y., 1922. (Translated from the French by A. D. Williams.)

[6] (*a*) W. Trinks, chapter on "Movement of Gases in Furnaces," p. 399 of reference 4(*a*).

(*b*) W. Trinks, chapter on "Combustion Devices and Heating Elements," pp. 102–103 of reference 3.

[7] There is a book, published in France, pertaining to the ceramic industry, which discusses the physics of a downdraft kiln and the pumplike action of the furnaces. Unfortunately the name of the book, the name of the author, and the publisher are unknown to the writer of this paper, who apologizes for being unable to trace it down.

[8] Ellis Lovejoy, chapter on "Furnaces," p. 147 of reference 2.

[9] W. Trinks says, "It may be remarked that the purpose of this scheme is frustrated if pieces are piled in front of the inlet port," p. 166 of reference 3.

The setting should be lowered so that an ample "throat" is provided through which furnace gases may sweep unobstructed over into the kiln. If the setting of the ware in front of the furnace is properly streamlined, velocity will not be lost. It will facilitate the tempering of the flame by mixing with gases already under the crown and will increase the path through which secondary combustion takes place, that is, it will tend to develop the inherent value of long flame.

(2) Gases from the Ware

During watersmoking, a large volume of steam is generated. The oxidation of carbon and pyrites also produces a volume of gas. While these impurities are being oxidized in the hotter parts of the kiln, gas is probably being generated in the cooler parts by the process of "roasting."

If the clay is high in carbon and pyrites and if the kiln is on a fast firing schedule, these gases possibly may be as high as 5% of the total gases passing through the kiln when 200% of excess air is used in the furnace. If 100% of excess air is used, the gases probably amount to 10% or more of the total gases to be handled by the kiln.[10] As the firing schedule is increased, even with a strong draft, a point will be reached when the kiln will "choke."[11] It seems likely, as the brick in the bottom of the kiln begin to lose sulfur and carbon by roasting, that this additional volume of gas is the "straw that breaks the camel's back" and chokes the kiln. To overcome this choked condition, firing must be stopped almost completely for a considerable time. If choking were caused by frictional resistance alone, a slight reduction in the rate of combustion should relieve the situation.

The point at which a brick kiln will choke limits the speeding up of the firing schedule. When the internal resistance is decreased, the firing again may be resumed on a fast schedule.

One way to decrease internal kiln resistance is to open up the setting, but this cannot be practiced on a building brick because more open setting increases kiln marking. If the height of the setting is lowered, the internal kiln resistance will be reduced so that a fast firing schedule may be used.

Reducing the height of the setting not only reduces the internal kiln resistance, but it also provides more space for flame tempering and provides the larger space which delayed combustion requires.

Cutting down the height of the setting often gives a surprising increase in the velocity and distribution of the gases passing through a downdraft kiln without resorting to expensive means of providing stronger induced or forced draft. High stacks or mechanical draft may not be needed.

According to tradition, fuel economy is secured by setting all the brick in a kiln that can be crowded into

[10] Estimate of the volume of these gases was made by applying data (furnished by D. B. Hendryx, chief engineer, Harbison-Walker Refractories Co., Pittsburgh, Pa.) to a Pennsylvania shale used for face brick.

[11] Ellis Lovejoy, chapter on "Stacks," p. 108, reference 2.

it. This tradition has little foundation in fact. Too frequently the kiln is so flagrantly overloaded that the firing period is excessively prolonged. Common brick are usually set very high and very tight. When the overfired and the underfired brick are deducted from the total setting, however, the fuel economy per ton of net saleable ware is not remarkable.

V. Conclusion

The setting of a downdraft kiln should be done in such manner that there is room for the furnace gases to flow smoothly into a combustion chamber left between the top of the setting and the crown. It should also be arranged so that the gases can move directly downward through the ware from this combustion chamber.[12]

[12] W. E. Groume-Grjimailo, chapter on "The Fundamental Viewpoint," pp. 4–8 of reference 5; on p. 89 is a discussion of gases giving up their heat.

A common brick kiln, containing 100,000 brick and turned over every twenty days, will produce 150,000 brick per month. The same kiln, set with 75,000 brick and turned over every fifteen days, will also yield 150,000 brick per month. If the height of the setting of a kiln, normally containing 100,000 common brick, is reduced so that it will hold only 75,000 brick, this setting may be set, fired, cooled, and drawn in proportionately less time for each operation. The net result, in a great many cases, would be no loss of kiln capacity but a savings in fuel and more saleable, uniformly fired brick.

No definite rules for the exact number of brick to be set in a downdraft kiln can be given in a paper of this kind. Each operator should determine, by experimentation and careful records, the most economical charge for his particular conditions.

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Darlington, Pennsylvania

PYROMETRIC RINGS FOR MEASURING KILN HEAT TREATMENT*

By Lowell H. Milligan

Abstract

Pyrometric cones are usually employed as the standard for measuring ceramic kiln heat treatment. These cones are satisfactory when their deformation characteristics are proportional to the maturing characteristics of the ware being fired. In the case of certain abrasive products, however, consisting of refractory granules bonded with ceramic mixtures which are matured to a bond relatively high in glass phase, the maturing characteristics of cones are not always a satisfactory measure of the properties of the product. "Pyrometric rings" therefore have been developed for use in place of cones. These rings, approximately $1^1/_2$ inches in outside diameter, $^3/_4$ inch high, and with a $^7/_8$-inch diameter hole, are molded from the same kind of raw ceramic powder used for cone manufacture. A powder of a composition ordinarily used for cones 9 or 10, however, is employed to mold the rings to be used for measuring heat treatment near cone 12. In other words, the deformation characteristics of No. 9 or No. 10 cone powder are employed for quantitative measurements of heat treatment near cone 12. The ring is set on a refractory plate and is given the kiln heat treatment along with the ware. Plug gauges are used to measure the hole remaining in the ring after the fire, and these are calibrated in terms of the strength of bonding of the product being fired.

I. Introduction

Pyrometric rings are merely a device by which the effectiveness of heat treatment on ceramic objects relatively high in glassy phase can be measured in terms of a single number that is calibrated to indicate directly the particular maturing characteristics it is desired to measure.

They are useful for determining whether or not ware being fired has received the proper heat treatment in the kiln and for measuring the distribution of heat throughout ceramic kilns. They cannot be used as a visual aid to kiln firing in the manner that is possible with pyrometric cones, the different numbers of which show a progressive deformation with advancing heat that is observable from outside the kiln.

II. Pyrometric Cones

The characteristics and uses of the ordinary pyrometric cones now used in the ceramic industry are discussed in a booklet, The Properties and Uses of Pyrometric Cones.† Some of the statements made are quoted as follows:

> Cones are used, primarily, for two purposes . . . to determine the advance of the heat in the kiln at a particular point, the bending of a particular cone denoting the point at which the ware is matured. In addition to this service, cones are set in various parts of the kiln to determine the

* Presented at the Forty-Second Annual Meeting, American Ceramic Society, Toronto, Canada, April 8, 1940 (General Session on Kiln Firing). Received May 15, 1940.

† Issued by the Edward Orton, Jr., Ceramic Foundation of Columbus, Ohio.

heat distribution. These cones are set blind. In other words, they can only be examined when the kiln is drawn.

Cones are not temperature-measuring devices as are pyrometers. They measure what is known as heat-work. Heat-work is a measure of the effect of time and temperature combined. Cones measure the degree of maturity of a ceramic body rather than the temperature at which it matured.

The cones are slender, trihedral pyramids made of a mixture of minerals very similar to the minerals of which the ceramic bodies are composed . . . the cone bodies and the ceramic bodies are sufficiently alike so that they react nearly the same thermochemically.

The cone bodies are so compounded from mixtures of china clay, feldspar, whiting, and flint that they deform under heat at regular advancing temperature intervals.

These cone bodies behave thermochemically so much like the ware in its maturing that they serve as invaluable guides to the proper firing of all ceramic products.

The bending of a pyrometric cone throughout its measurement range takes place as the viscous glass phase is formed in the ceramic mixture composing the cone. The physical characteristics of the fired ceramics that constitute cones which have been fired within their deforming range correspond to many ceramic products of the nature of brick, chinaware, etc. For such products, the cone bodies do behave thermochemically so much like the ware in maturing that the cones measure the joint effect of time and temperature on the ware. Under such conditions, firing on different time schedules may be compensated for with reasonable accuracy by maintaining cone deformation substantially constant.

(1) Cones Do Not Always Measure Ware Maturity

In the case of certain abrasive products, however, which consist of refractory granules bonded with ceramic mixtures that are matured to a bond relatively high in glass phase, the maturing characteristics of cones are not always a satisfactory measure of the properties of the product. This is apparently because the development of glass phase in the ceramic cone body during deformation of the cone does not sufficiently parallel that in the bond of the abrasive product under discussion. It is thought that glazes and other similar glassy products also come within this classification.

Because of these conditions, methods were studied by means of which a numerical measure of maturing could be obtained for a standard ceramic cone powder mixture in the time-temperature range where considerable glass phase is being developed.

III. Description of Pyrometric Rings

Pyrometric rings were developed to obtain a quantitative measure of maturing for products high in glass phase and have proved to be satisfactory. The rings are made by pressing in a steel mold the standard pyrometric cone powders obtained from the Edward Orton, Jr., Ceramic Foundation. The rings thus produced are $1^{17}/_{32}$ inches in outside diameter, $^{7}/_{8}$ inch in hole diameter, and $^{3}/_{4}$ inch high; and the cross section of a ring is rectangular in shape, $^{21}/_{64}$ inch wide by $^{3}/_{4}$ inch high. Each ring is molded to weigh 26.0 grams in the dried condition.

The same kind of raw ceramic powder mixture that is used for cone manufacture is used to mold the rings, except that a powder of the composition ordinarily used for cones 9 or 10 is employed for pyrometric rings to be used at heat treatments in the vicinity of "cone 12." The powder before molding is moistened slightly with a water solution of a temporary binder, but care should be taken to select a temporary binder that does not affect the deforming characteristics of the rings under the firing conditions employed. Solutions of Glutoline (methyl ether of cellulose) and also of dextrine have been used satisfactorily.

The number assigned to a pyrometric ring means that the ring is made from the same ceramic powder mixture as an Orton standard pyrometric cone of that same number.

The rings are set on a small refractory plate and are given the heat treatment along with the ware. For many purposes, one ring will be sufficient. The usable deformation range extends from a heat treatment that causes the upper edges of the ring to round over and the ring cross section to increase slightly in width from its minimum value reached by shrinkage, up to the point where the hole in the ring closes and the ring becomes a circular glassy puddle.

Measurements of deformation may be made readily by recording either hole or outside diameter, and even the height of the ring may also be used. It has been found, however, that hole measurements by means of plug gauges are the most convenient, and, furthermore, the hole dimension is less subject to the influence of variable kiln atmospheric effects than is the outside diameter.

Figure 1 shows an unfired pyrometric ring with the refractory plate on which it is set in the kiln. In Fig. 2, cones and pyrometric rings are shown that were fired together in different commercial kilns. Pyrometric rings Nos. 9 and 10 are used in the deformation range of cone 12. The rings indicate an increase in heat treatment in the order of tunnel-kiln schedule A, tunnel-kiln schedule B, and the large periodic kiln; whereas the position of cone 12, which is within its cone deformation range, does not indicate a corresponding increase in heat treatment.

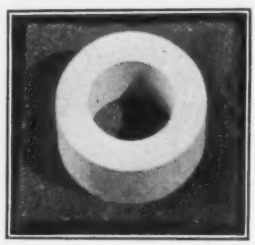

FIG. 1.—Unfired pyrometric ring and plate.

Figure 3 shows pyrometric cones and rings that were fired together and have swelled due to an abnormal kiln atmosphere. Both the cones and the rings, in general, are similarly affected, but it should be noted that swelling has not occurred to the same degree in the holes of the rings as on their external surfaces.

In Fig. 4, a series of rings is shown, fired in a laboratory furnace at 1250°C., with the time of soaking varied from three to forty-eight hours. These rings illustrate the way in which deformation occurs with increasing

time at a constant temperature. Quantitative data on these and similar other laboratory tests with rings are presented in Tables I, II, and III.

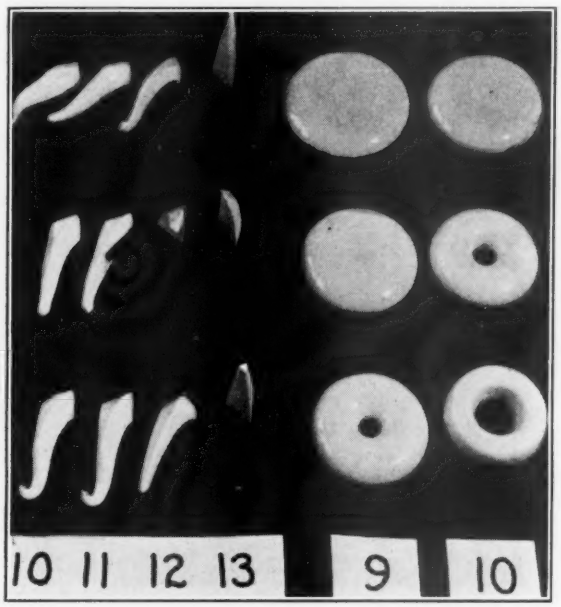

FIG. 2.—Cones and rings fired together. *Top*, large periodic kiln; *middle*, tunnel-kiln schedule B; *bottom*, tunnel-kiln schedule A.

FIG. 3.—Pyrometric cones and rings showing swelling caused by abnormal kiln atmosphere.

IV. Sensitiveness of Pyrometric Rings

The pyrometric-ring method of measurement has been shown to be a very sensitive method of measuring heat-treatment differences in commercial kilns. In muffle-type tunnel kilns operating near cone 12, for instance, it has been found possible within a single sagger to measure differences from spot to spot in the sagger. In certain tests under such conditions, it was possible to show consistent and measurable differences in heat treatment between rings spaced only two inches apart in the sagger, although, of course, the actual magnitude of such heat-treatment differences was extremely small.

V. Usable Time-Temperature Deformation Range

To study the deformation characteristics of pyrometric rings of different numbers with different lengths of soaking time at different temperatures, several

TABLE I

HOLE DIAMETERS MEASURED (IN CENTIMETERS) FOR PYROMETRIC RINGS FIRED WITHIN THEIR USEFUL DEFORMATION RANGE

Rings fired in laboratory electric kiln with soaking time varied from 3 to 48 hours at temperatures indicated.

Ring No.	Temp. (°C.)	Length of soak (hr.) 3	6	12	24	48
1	1150	1.18	0.65	Closed		
3	1150	1.69	1.65	0.67	Closed	
3	1200	Closed				
5	1150			1.82	1.69	1.56
5	1200	1.10	0.83	Closed		
7	1200		1.81	1.70	1.66	1.57
8	1200			1.84	1.80	1.72
9	1200					1.87
9	1250	1.86	1.83	1.62	1.41	0.90
9	1300	1.07	0.82	Closed		
10	1250			1.87	1.79	1.54
10	1300	1.56	1.46	0.83	0.20	Closed
11	1300					1.82

runs were made in an automatically controlled laboratory electric furnace. The temperature of the furnace was maintained constant within about 5°C., and sets containing the rings were withdrawn at the end of 3, 6, 12, 24, and 48 hours, respectively. Runs were made at temperatures of 1150°, 1200°, 1250°, and 1300°C. Suitable ring numbers were tested in each case so that their usable deformation range would cover the time-temperature range being studied.

Table I presents the data obtained for hole diameters of the rings measured in centimeters, values being given only for rings that are considered to be within

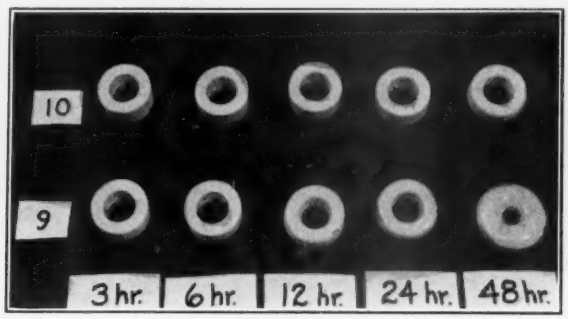

FIG. 4.—Pyrometric rings with varying time of soak at 1250°C.

their useful deformation range. Tables II and III present data, respectively, for the outside diameter of rings and for the height of rings.

The data in Table I have been plotted as curves in Figs. 5 and 6. The hole measurement of a ring fired under unknown conditions may be converted readily by means of these curves into values for the time-temperature conditions under which it was fired. For example, if the time of soak is fairly well known, then the equivalent temperature at which the heat treatment was carried out may be estimated with a fair degree of accuracy. Such calculations can be made for a number of rings set in different kiln positions to determine the distribution of heat throughout the kiln.

If desired, the data for the outside diameter and the height of the rings given in Tables II and III may also be studied in the form of plotted curves. Such curves

for outside ring diameter vs. time of soak show an inflection point where the hole closes. There is evidently a slowing up of outside diameter increase at this point while the hole in the ring fills in.

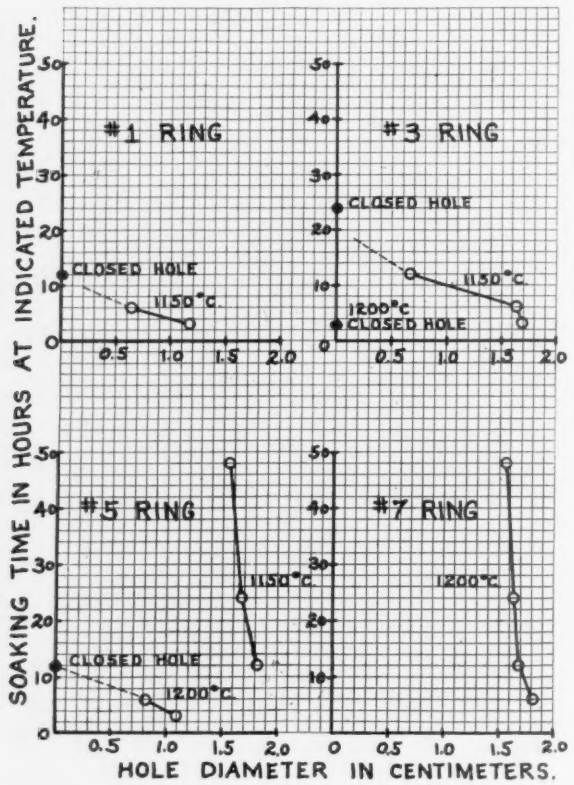

FIG. 5.—Curves for hole diameter of pyrometric rings Nos. 1, 3, 5, and 7 vs. soaking time at 1150° and 1200°C.

TABLE II

OUTSIDE DIAMETERS MEASURED (IN CENTIMETERS) FOR SAME PYROMETRIC RINGS SHOWN IN TABLE I

Ring No.	Temp. (°C.)	Length of soak (hr.) 3	6	12	24	48
1	1150	4.21	4.44	4.82	4.85	5.07
3	1150	3.67	3.72	4.42	4.60	4.72
3	1200	5.12	5.30			
5	1150	3.42	3.43	3.52	3.65	3.84
5	1200	4.11	4.27	4.44	4.53	
7	1200	3.51	3.56	3.68	3.70	3.80
8	1200			3.55	3.62	3.70
9	1200					3.58
9	1250	3.60	3.65	3.93	4.13	4.47
9	1300	4.41	4.51	4.82		
10	1250	3.54	3.58	3.60	3.71	3.98
10	1300	3.98	4.07	4.52	4.71	5.20
11	1300	3.63	3.61	3.64	3.63	3.67

VI. Calibration of Ring Deformation

It is not the purpose of this paper to discuss in detail the various methods that can be used to calibrate ring deformation in terms of heat treatment for products being fired. This may be done, however, in many ways, depending on how the characteristics of the ware being fired are affected by heat-treatment variations.

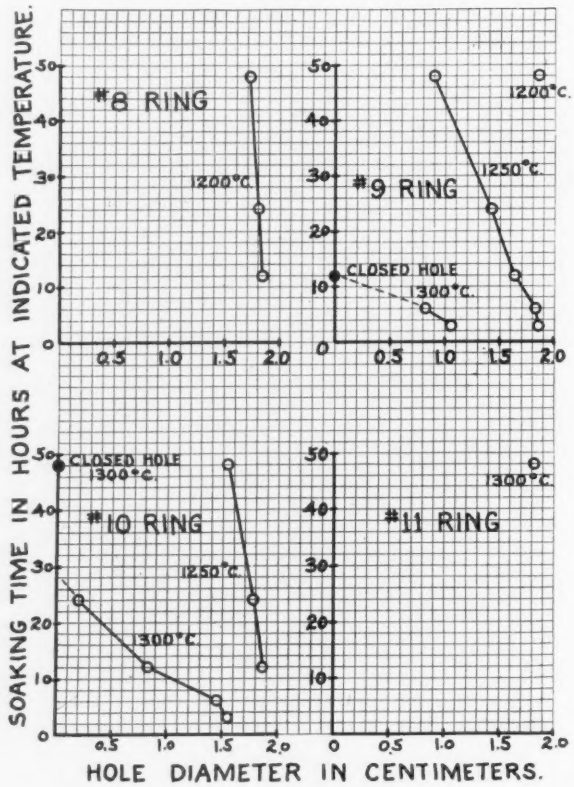

FIG. 6.—Curves for hole diameter of pyrometric rings Nos. 8, 9, 10, and 11 vs. soaking time at 1200°, 1250°, and 1300°C.

TABLE III

HEIGHT OF RINGS MEASURED (IN CENTIMETERS) FOR SAME PYROMETRIC RINGS SHOWN IN TABLE I

Ring No.	Temp. (°C.)	Length of soak (hr.) 3	6	12	24	48
1	1150	1.08				
3	1150	1.45	1.38			
5	1150	1.68	1.67	1.61	1.46	1.32
7	1200	1.58	1.57	1.43	1.42	1.34
8	1200			1.63	1.58	1.49
9	1200					1.65
9	1250	1.65	1.62	1.40	1.23	
10	1250	1.71	1.72	1.63	1.56	1.35
10	1300	1.35	1.27			
11	1300	1.65	1.68	1.67	1.70	1.63

A good way to proceed is to select some important quantitatively measurable property of the most sensitive ware and to use this property for the full commercial range of the heat treatment employed. Such a property, for instance, might be the strength or the shrinkage of the ware.

If the heat-treatment range it is desired to measure is greater than the usable deformation range of a single number of pyrometric ring, then calibration should be covered for rings made of two or more powder numbers.

The term *equivalent heat treatment* is a satisfactory one to use in connection with measurements made by pyrometric rings, for it implies the equivalence between the ring measurement and the ware properties.

The ring is merely a convenient and quick method of measuring the effect that the heat treatment would have on ware set at the point in the kiln where the measurement is made. If parallelism between ware characteristics and ring-deformation characteristics cannot be established, then pyrometric rings cannot be used satisfactorily for measuring the equivalent heat treatment of that particular kind of ware.

If parallelism, however, can be established, then pyrometric rings may be used to advantage, and they serve as a convenient, sensitive, and accurate method for obtaining a numerical measure of heat treatment in terms of a single number that represents an important characteristic of the ware being fired.

Acknowledgment

Much of the experimental work connected with the development of pyrometric rings has been carried out by Robert H. Lombard, and acknowledgment of his valued services is made. The data on the usable time-temperature deformation range of rings were obtained by O. Mason Burrows. Thanks are also expressed to Norton Company for permission to publish this paper.

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Norton Company
Worcester, Massachusetts

THE OVERSTROM MUD SCREEN*

By G. W. Jarman, Jr.

Abstract

The design and use of the Overstrom mud screen in the ceramic industry is described for slips, enamels, clays, or liquids, bearing particles from which a relatively small amount of oversize is to be removed and in which the quantity to be handled per hour is large.

I. Introduction

The art of screening or lawning as it is known in the ceramic industry goes back to ancient history. It was first started by hand-picking, progressing to the use of "grizzlies," flat screens, trommel screens, both round and multiplesided, until the shaking screen was developed. To understand the various screen motions, research in physics has been necessary. The throw of the screen causes particles to take a certain trajectory and to land at a certain place at a certain time with a certain direction.

Close sizing or screening is the goal sought, and the efficiency of the screen may be determined by noting the number of particles that do not pass any screen surface, although in the ceramic industry there are few oversize particles. The "overs" in slips, glazes, etc., amount only to a small percentage of the "throughs." As far as the ceramic industry is concerned, therefore, another definition of the word "efficiency" in screening or lawning must be sought. Efficient screening in the mining industry is commonly accepted as around 85%, that is, only 15% of the material which should have gone through fails to pass. If the ceramic "overs" contain 15% of finer material, it is not a serious matter because so little goes over the top anyway.

II. Standards for Ceramic Materials

Because it is necessary to set up some other standard of efficiency, the use of the ceramic materials to be screened or lawned should be examined. In certain instances, the lignite content in the clay should be removed not only efficiently but rapidly; otherwise the lignite, which is very friable, will break up and come through. Screening at low cost is also important, involving such factors as depreciation, power, labor, and repairs. It is natural, therefore, that the use of a screen, which handles particles efficiently in the milling industry and at the same time without too violent a motion and in high capacity, results in what might be called "over-all efficiency."

The ceramic industry formerly lacked data on processes being used in such general fields as the mining or chemical industries, although more data are available at the present time. For example, the Cottrell precipitator, used by smelters, is now being used in the recovery of glaze and enamel dusts. More study is being made on the possibility of the far less expensive grinding with iron media rather than with stone, the iron contaminant being removed by high-intensity magnets.

III. History of Overstrom Mud Screen

The use of the Overstrom mud screen is another development. When oil wells are drilled by the rotary method, a fluid known as "rotary mud" is used, which consists of bentonite, ground barite, and clays suspended in water. The drill stem and the pipe are hollow, and the rotary mud is forced by the pump down through the center of the stem and pipe to the bottom of the hole. As the mud leaves, the hollow drilling apparatus picks up the cuttings which the drill has made, and the mud rises in the space existing between the exterior drill-pipe wall and the interior casing wall until it reaches an outlet below the turntable, located on the floor of the derrick at ground level. In addition to picking up the cuttings, the rotary mud has the property of holding back gas pressure encountered in drilling the wells. It is obvious that a column of water, weighing 8.32 lb. per gallon, has far less pressure

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resistance than if it weighs 12 lb. per gallon. The mud, therefore, is frequently weighted with baroid, a ground barium sulfate, causing the introduction of between $10,000 and $30,000 worth of weighted mud per well when gas conditions are severe. If these cuttings are pumped back again, not only will the slush pump valves, pistons, and cylinders be quickly cut to pieces (in some instances, this cutting has occurred in twenty-four hours) but they would increase in startling quantity.

The oil-well operators, therefore, presented to the vibrating screen manufacturers the problem of handling about 24,000 gallons per hour per well to be screened on a 20- by 30-mesh slotted opening. The lawns used in the ceramic industry could not be used because of their ton capacity and because the slush screens on sands would "blind" up in record time.

(1) Work of Overstrom

During the period of 1917 to 1921, Gustav Overstrom, an authority on the subject of ore concentration, tabling, and screening, developed a vibrating screen of superior design. It was necessary to handle the required capacity without the loss of valuable mud over the top of the screen and to develop a foolproof mud screen because, with too coarse a cloth, the abrasive materials cut the liners of pumps and pistons as well as valves.

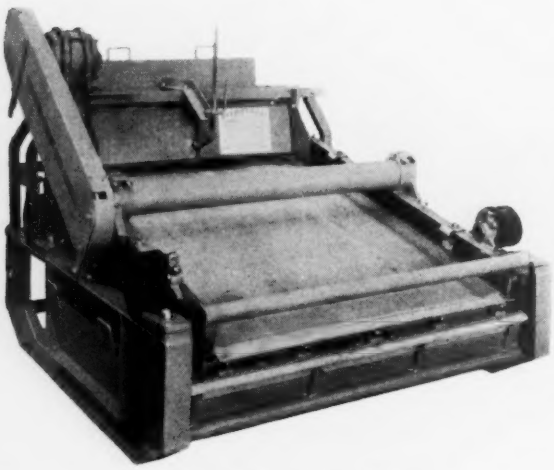

FIG. 1.—Overstrom mud screen.

Professor Overstrom, in 1921, had already developed a vibrating screen, and one of his sons, working for an oil company in California, brought up the problem of screening oil-well mud to about 30-mesh. Preliminary experiments on mud showed that it could be screened, but considerable experimenting and redesigning were necessary to achieve the desired results. In 1930, larger pumps were in use and the cost of their upkeep mounted so rapidly that further experiments on the mud screen were made. Larger slush pumps are now being installed, which has permitted oil-well drilling speed to be increased. Originally, a screen was used with a capacity of about 24,000 gallons per hour; a mud screen can now handle from 55,000 to 60,000 gallons per hour through a 30- by a 20-mesh screen.

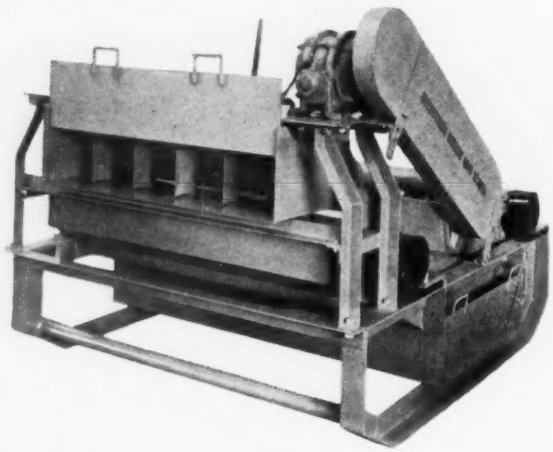

FIG. 2.—Rear view of Overstrom mud screen showing distributing box.

IV. Use of Screen in Ceramic Industry

The use of this screen seemed to be applicable to the ceramic industry, whereby efficient screening would be possible in less time and finer sizes would be obtained with the resultant change in quality.

The screen cloth is 5 feet long between binders and 54 inches wide, with an actual free-screening area of 20 sq. ft. The screen is stretched tight both longitudinally and transversely. The screen-cloth supports are longitudinal rubber inserts fitting in dovetail slots milled in 8-lb. steel rails. The screen deck is supported on four coil springs in perfect balance, as the spring centers are in alignment with the center of gravity of the vibrating system. The screen frame itself is agitated by an unbalanced shaft in alignment with the center of gravity of the screen box. The r.p.m. is 1750 for oil-well mud and about 1540 when handling slip; the screen uses 2 h.p. for starting and 1 h.p. when running. It weighs about 1600 lb. and its dimensions are 5 ft. 9 in. by 5 ft. 4 in., requiring 27 in. of height from the inlet to outlet headroom. Oil is used for lubrication and all shafts and the bearings are entirely surrounded by a protective tubing which is clamped in steel castings welded to the side of the screen box.

The motion of the Overstrom screen is about $^1/_{16}$ inch, and no jolts or jerks are exerted on the material because of the nearly concentric motion produced by the unbalanced shaft. The motion is taken up on the spiral springs. The screen surface is crowned lengthwise, which keeps the taut cloth hugging its rubber supports.

The conveying motion is fast, and as the amplitude is only about $^1/_{16}$ in., lignite particles will go off in the oversize before they disintegrate into the screened slip. The oversize, which is heavy and very sticky, might have a tendency to do the same thing which has been noted in some of the potteries, namely, to get off the edge of the lawn and then creep up underneath. To prevent this, a flexible closure seal was attached to the

box which carries the screen and to the stationary base. A feed box was also necessary, owing to the irregularity of feeding by pumps. A gate, with transverse adjustment and vanes, was inserted to direct the flow of the material as well as a swinging gate for final adjustment so that all the surface of the screen is covered evenly across it. On a slip of ordinary viscosity, the screen capacity is about 100 gallons per minute at 120-mesh.

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GETTING THE BEST PRODUCTION FROM A BALL OR PEBBLE MILL *

BY O. F. REDD

ABSTRACT

The mill size; size, shape, and amount of grinding media; mill speed; and the amount and consistency of the charge are given in relation to their grinding efficiency.

I. Introduction

There are few processing machines that are as versatile as a ball or pebble mill. These mills have been used (1) for dry grinding, (2) for grinding and dispersing solids in liquids simultaneously, the product having a viscosity slightly greater than water, and (3) for grinding at such high consistency that the product is discharged by injecting air into the mill to force the material down more rapidly through the interstices between the balls. Naturally a mill with this great range of adaptability also has an equally great range of operating conditions under which passable results are obtained.

There is apparently considerable confusion as to just what operating conditions are the most economical. Because in many processes the ball or pebble mill accounts for only a small part of the total expense, there is little inducement for careful or prolonged investigation. Sometimes a mill is intentionally operated under inefficient milling conditions because other steps in the process or a certain size distribution of the ground material is more important than the most economical grinding. There is also almost as much confusion as to just what results are wanted as there is in mill operation. Specifications usually call for a minimum percentage of the product to pass a specified sieve with no requirement made as to the size distribution of material passing that sieve. This size distribution, however, may greatly affect the physical properties of a suspension, and it should be considered in selecting grinding equipment or in standardizing the milling routine.

(1) Operating Variables

When grinding requirements vary so greatly, no definite set of rules can be given. A discussion, therefore, of each of the operating variables and their interrelation will be presented. These variables, in the order of their discussion, are mill speed, the amount of grinding media, the size of grinding media and of material charge, and the amount and consistency of the material. A standard set of operating conditions will be selected and the effect of the deviation of each variable will be given.

II. Mill Speed

The speed of a ball mill affects the path which the balls follow in grinding. A mill may be operated so fast that part of the balls will be centrifuged against the shell and have no motion relative to it. In this case, the material trapped between the balls is not ground. At the other extreme, the mill may be operated so slowly that the balls rise with the shell until they reach the angle of repose and then roll or slide downward, en masse, to be elevated again. The sound of the mill will reveal either of these conditions to an experienced operator, the surge of material in an undercharged slow mill being particularly noticeable. Between these two extremes, there is a correct speed at which the balls nearest the shell are elevated 30 to 45 degrees above the horizontal, leave the shell, and continue their upward flight to fall in an unpulsating stream through a distance nearly equal to the mill diameter. The main grinding action becomes that of trapping material in a cascade of falling balls or pebbles and crushing it by impact as the downward flight of the balls is abruptly checked.

The speed for correct grinding action is related to the mill diameter, and similar action is obtained in large or small diameter mills if each operates at the same percentage of its critical speed. The critical speed may be defined as the angular velocity at which the centrifugal force on a small particle, in contact with the mill shell, is equal to its weight. This critical speed, in revolutions per minute, is equal to $54.19 \div \sqrt{R}$ (R is the inside mill radius in feet).

The correct mill speed is seldom less than 50% or more than 75% of the critical speed. If the mill is correctly charged so that slippage between the shell and charge is reduced to a minimum, the most rapid grinding will occur at 65% of the critical speed, and the most efficient grinding, based on power consumption, will occur at 50% of the critical speed. Most manufacturers have selected standard speeds within this

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range. Small mills are often operated at a higher percentage of their critical speed to compensate partially for the slower grinding that is naturally obtained in mills of small diameter.

If the mill is undercharged or if the properties of the material are such that excessive slippage occurs, the results may be improved by increasing the speed. Before the speed is increased, however, an attempt should be made to reduce slippage, because excessive slippage causes rapid abrasion of both the shell and the grinding media. When excessive slippage occurs, it can often be corrected (1) by increasing the ball or pebble charge to fill the mill to its axis, (2) by increasing the amount of the material charge, or (3) by lowering the consistency of the charge.

III. Charge of Grinding Media

Considerable variation in the amount of grinding media is permissible. The charge of balls or pebbles is based on the total capacity of the mill, and the interstices between the balls are considered part of the charge, i.e., a 50% charge is one that would fill the mill to its axis although considerably less than 50% of the mill would be filled with flint or porcelain. The weight of the balls constituting this 50% charge will vary with the size distribution if they are not uniform.

A charge of balls greater than 50% is seldom desirable. The most economical operation is usually obtained with a ball charge of between 45 and 50%, and occasionally a ball charge as low as 40% will give good results. The foregoing remarks apply to the reduction of size of homogeneous particles. When particles, lightly bound into aggregates, are to be broken down to their natural grain size and suspended in a liquid (e.g., in using a ball mill as a blunger and in dispersing precipitated pigments in a vehicle), a ball charge as low as 20% is sometimes permissible.

The amount of grinding media may affect the choice of mill speed. Mills with a 45 to 50% charge should operate at 50 to 65% of their critical speed. The cascading effect and impact grinding will be decreased with a low charge unless the mill is operated at a higher percentage of its critical speed than has been specified for a normal charge. A low charge and high speed, however, are seldom advisable because the balls fall diagonally along the mill diameter and impinge on the mill lining instead of falling on other balls as in the case of conventional operation.

IV. Size of Grinding Media

The selection of the ball or pebble size is determined by the size of the largest particles in the unground material, the minimum size desired in the product, the mill diameter, and the physical properties of the material being ground. When one of the largest balls falls three fourths of the mill diameter, its kinetic energy must be sufficient to break the largest particles; otherwise, those particles will be only slightly reduced by surface abrasion. Balls should be no larger than is required for the initial crushing because otherwise the number of impacts per revolution is decreased with a proportional increase in grinding time. In prolonged grinding, each size ball has an apparent limit beyond which it will not reduce the product. Further reduction is obtained by the use of smaller balls.

The selection of grinding media provides some control of the size distribution of the product. When two batches, for example, are ground to 98% passing the 140-mesh sieve, one with 3-inch and the other with $1^1/_2$-inch balls, other conditions being equal, the batch ground with the large balls has a greater percentage retained on the 270-mesh sieve.

Many rules have been given for selecting pebble size, nearly all of which ignore the crushing strength, elasticity, and mill diameter, and these rules are seldom accurate except for the particular operation from which they were derived.

A complete sieve analysis will reveal incorrect ball or pebble size. Most specifications require a minimum percentage through a specified sieve. The operator usually runs the mill the minimum time required to comply with the specification. If the ground material retained on the test sieve consists of a relatively few large particles with abraded edges, it is obvious that the grinding media are too small to produce the initial fracture. When only the material through a lawn is available, the incorrect charge is not so apparent. In this case, the product should be sifted through a complete set of test sieves beginning with the lawn opening. If it is found that a negligible amount of the product is retained on the coarser sieves, there is a possibility that the operator is overgrinding the fines in an attempt to produce the initial fracture of a few large particles.

When a high percentage of the product passing the lawn is retained by the finer sieves, grinding time may often be decreased by recharging the mill with smaller balls. If smaller balls are not available, the ratio of material charge to ball charge can be increased with almost the equivalent effect on size distribution. The grinding time will be increased, but the weight of the product per batch is also increased so that there is not a great loss of mill efficiency.

V. Consistency

Almost any batch of material that has a consistency that will permit its being discharged may be successfully ground in a ball or pebble mill. An established practice in the paint industry is to grind at high consistency and to thin the batch a few minutes before discharge. High consistency permits the grinding of more solids per batch because mills are charged on the basis of volume. Another advantage is that high consistency decreases the abrasion of the mill lining and of the grinding media, provided it is not high enough to cause slippage. It also increases grinding time but not necessarily in direct proportion to the amount of solids. It should be adjusted by experiment because the consistency of many suspensions varies with the degree of agitation, and the shear rates in viscosimeters are not comparable to the agitation produced in a ball mill. For example, the percentage of solids may be varied and the ratio and the weight of the solids divided by the grinding time may be calculated; then from this ratio the maximum consistency is obtained.

VI. Summary

An application of these suggestions may be given by selecting a mill, 4 feet in diameter by 5 feet, and by specifying reasonable operating conditions. Mill sizes are usually specified by giving the dimensions of the unlined cylinder. Allowing 4 inches on both dimensions for a lining thickness of 2 inches, a critical speed of 40 r.p.m. and a volume of 49.3 cubic feet are obtained. These constants form the basis for estimating operating conditions.

An operating speed of 23 r.p.m. will be selected, which is 57.6% of the critical speed. This speed lies between the most rapid and the most efficient grinding and permits some slippage before efficiency is lost.

A ball charge equal to 50% of the mill volume will be selected. A reasonable average apparent density for porcelain is 100 pounds per cubic foot, making the ball charge 2465 pounds.

The materials charge should be at least enough to fill the interstices between the balls. As the apparent density of the balls is 100 pounds per cubic foot and the absolute density is 153 pounds per cubic foot, the volume of the interstices is 34.8% of the volume of the ball charge, i.e., 34.8% × 50% × the mill volume, or 8.56 cubic feet is the minimum charge to be used without removing part of the grinding media. This materials charge can and should be increased. A charge between 20 and 25% of the mill volume usually gives best results.

The last suggestion is that neither the foregoing example nor the methods now in use should be accepted as final. The grinding operation should be examined critically, and the suggestions given here together with personal judgment should be used as a guide to better grinding.

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METHODS OF BODY PREPARATION AND THEIR EFFECT ON DUST PRESSING OF WALL TILE*

BY RICHARD F. EVANS

ABSTRACT

The effect of various commercial methods of body preparation on a single body composition in relation to pressing behavior, density, and laminations is discussed. The effect on the shrinkage, porosity, and strength of the fired tile is also given.

I. Introduction

New methods of body preparation for encaustic wall-tile bodies have been developed in recent years to reduce the cost of preparation. The most important of these methods has been the dry mixing or blending operation which has eliminated wet ball milling or blunging, filter pressing, drying, and tempering, each accomplished by separate operations. With the dry-mixing operation, all crude materials are dry ground to a specified fineness and then mixed or blended, and the moisture is added without further refinement. The mixing or blending is accomplished practically by one operation, thereby eliminating many of the expensive operations encountered by the wet refining method. All of the crude materials must be selected with great care for the dry-mixing method. There should be a minimum of organic material and freedom from all metallic oxides that might affect the color of the finished product. If the crude materials contain small quantities of impurities, they can generally be ground fine enough to reduce their effect in the finished product to a negligible degree.

The dry-mixing method of body preparation and the types of equipment used, their effect on pressing behavior, fired absorption, shrinkage, and breaking strength are discussed herein. The comparable results with an identical body composition prepared by the wet method are also described.

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II. Wall-Tile Body Compositions

The three general types of wall-tile body compositions now used most widely by the trade are (1) clay, silica, and feldspar (or Cornwall stone); (2) talc, clay, and a low-fired flux composition usually made by the one-fire method; and (3) high talc and low clay. In the eastern states, considerable pyrophyllite is used in place of talc.

Composition No. 1, with clay, silica, and feldspar, is difficult to control to a specified size because of its high shrinkage, usually from 3 to 5%. This composition requires expensive washing and tempering equipment. It is lacking in the important property of thermal-shock resistance which has become increasingly important because of the trend toward a shorter glost-firing period to facilitate quick deliveries. High crazing resistance is generally more difficult to obtain in this type of body. Variations in pressing affect the shrinkage considerably. This body shrinks less with soft pressing than when normal or hard pressing is used. The shrinkage of trim shapes is affected materially when an equal density is not maintained throughout the piece; the soft portions of a piece will be large, whereas the more dense portions usually can be fired to the desired size. With manually operated presses, it is practically impossible to obtain uniform pressing; considerable size variations, therefore, are encountered in this body.

Composition No. 2, with talc, clay, and low-fired flux, produces a tile with the low shrinkage of 1 to $1^1/_2$%, a

high thermal-shock resistance, and good craze resistance. This body, however, reacts to a variable pressure when it is being formed, which is the opposite of composition No. 1. Greater shrinkage results when soft pressing is used. The same shrinkage problems are encountered with composition No. 2 as the first-named type even though the reaction to variable pressures is the opposite of the No. 1 clay-silica-feldspar body.

Composition No. 2 is a comparatively new body and much could be accomplished by further studies toward commercial development. It has tremendous possibilities because its rapid one-fire method of production requires smaller floor area per unit and because it permits quick delivery of orders.

Composition No. 3, with high talc and low clay and with the proper method of body preparation, has all of the desirable properties necessary to produce a body of low shrinkage that has high resistance to thermal shock and crazing. It is with this body that the use of different types of body-preparation equipment and the resultant comparable data will be discussed.

Low shrinkage is stressed particularly because the writer believes this to be one of the most desirable properties in the manufacture of tile. The trade is becoming increasingly insistent on dimensional tile, and it is demanding a product with a low-dimensional tolerance. The possibility of obtaining tile of uniform size is much greater if the shrinkage can be held to a minimum.

III. Tests on Body Composition No. 3

An identical body composition of high talc and low clay was used throughout in the four types of body-preparation equipment that were available for these trials. All samples were treated exactly alike in pressing, drying, and firing. The only difference was in the method of preparation of these bodies. The size of batch, of course, varied according to the capacity of each type of equipment.

(1) Ball-Mill and Filter-Press Method

The first method of preparation was accomplished by the wet process. A 2500-lb. batch was wet ground in a ball mill for one hour, drained over a magnetic separator through a 100-mesh screen and filter-pressed, and the filter cakes were dried. The dry filter cakes were then ground for 15 minutes in a 9-ft. wet pan with 8% of moisture, and the body was pulverized through a squirrel-cage type disintegrator and delivered to the press. The body pressed exceptionally well with no laminations or die sticking. The moisture at the press was 6%. The pressed ware was dense and comparatively strong.

(2) Wet-Pan Dry Method

For the second method of preparation, two 400-lb. batches of fine-ground dry materials were mixed for 15 minutes with 8% of water in a 9-ft. wet pan. This body was pulverized through the same squirrel-cage type disintegrator and delivered to the press. The moisture at the press was 7.1%. This body also pressed exceptionally well, showing no lamination or die sticking. The pressed ware appeared to be slightly stronger than the preceding body, probably owing to the higher moisture content of the body at the press.

(3) Simpson Mixer Dry Method

An 8-ft. Simpson mixer was used for the third trial. A 1200-lb. batch of the fine-ground materials was mixed dry for 5 minutes, 8% of water was added, and mixing was continued for 10 more minutes. The body was then pulverized in the squirrel-cage type disintegrator and delivered to the press. This body did not press so well as those by the first two methods. There was trouble with laminations, and there were a few cases of die sticking. This was rather surprising, because it had been thought that the use of the wet pan and the Simpson mixer might result in similar physical properties of the body. After checking the physical differences of the two pieces of equipment, the depth of the charge in the Simpson mixer was found to be three times that in the wet pan. Only a 400-lb. batch could be used in the wet pan because the centrifugal force would have discharged part of the batch over the side. The Simpson mixer pan is stationary and is also covered, thereby giving much greater capacity. Owing to the shallow depth of the charge in the wet pan, the cake formed under the mullers was much thinner and more compact than that formed under the mullers of the Simpson mixer. The face of the mullers on the Simpson mixer was approximately 50% wider than that of the wet pan, making it impossible to obtain the same pressure per square inch under the mullers of both pieces of equipment. This explains why the body from the Simpson mixer was not so compact as the other two bodies, thereby making it more difficult to press.

(4) Spiral Blender Dry Method

A spiral-type blender was used as the fourth method of preparation. A 1700-lb. batch of fine-ground dry material was mixed dry for 45 minutes, and 8.3% of water was added and mixed for 20 more minutes. The body was then discharged into a tube mill where the water was mixed thoroughly into the body. For test purposes, this body was taken to the press directly from the tube mill. In actual practice, about three days of aging before pressing are beneficial for this body in order to reduce laminations and die sticking. When a spiral blender is used, the materials should be selected carefully so that when they are finely ground they do not weigh less than 50 lb. per cu. ft. Fine-ground silica weighs about 70 lb. per cu. ft. and may be used as a basis of comparison for weights of other materials. Those that weigh less than 50 lb. per cu. ft. are usually so light and fluffy that laminations in pressing generally result. This body pressed well, producing only a few laminations and some die sticking. It contained 8.0% of moisture at the press.

IV. Conclusions

The wet method of body preparation produces the cleanest and whitest product of all the methods discussed. The shrinkage is increased considerably, but

TABLE I

PHYSICAL PROPERTIES OF TILE FIRED TO CONE 2, POSITION 4

Method of preparation	Moisture at press (%)	Total shrinkage (%)	Absorption (%)	Modulus of rupture (lb./sq. in.)	Color
Ball-mill and filter-pressed, wet process	6.0	1.63	12.15	6692	Very white; no specks
Wet pan, dry process	7.1	1.90	12.20	6108	White, with slight grayish cast from fine specks
Simpson mixer, dry process	7.45	1.23	15.25	4173	White, with gray cast from fine specks
Spiral blender, dry process	8.0	1.04	16.50	3250	White, with slight gray cast; very fine specks

this probably could be reduced by adjusting the body composition without greatly affecting the other desirable properties. With the materials used in these tests, body preparation by the washing and continuous filter-pressing process would probably be desirable if ware of exceptional whiteness and cleanliness is desired. A strong, dense product is produced by this method.

Dry mixing by the wet-pan method produces a strong, dense product, but the body has a grayish cast. Power consumption by this method is relatively high owing to the small batch capacity. The shrinkage is also relatively high.

With proper adjustments, the writer believes that the Simpson mixer would prove to be the best type of equipment for the dry-mixing operation. The size of the batch and the type and weight of the mullers economically produce a very fine product, on a par with that of the wet pan, if such properties are desired. The Simpson mixer used for these tests was installed for an entirely different purpose than that of making wall-tile bodies, and no effort or study was made to adjust it to this use at this time.

Comparable data on the tile produced from preparation in the four types of equipment are given in Table I.

The spiral-blender type of body preparation produced a product which has low shrinkage, a higher absorption, and less strength than those of the other three methods of preparation. Owing to the low shrinkage produced by this method, the tile are not subject to size variation when uneven forming pressures are encountered.

It is entirely possible to press the most difficult shapes that have hard and soft sections in the same piece without the slightest indication of distortion from uneven density. Several commercial tests were made on a number of tile pressed as hard as possible and on another set pressed only hard enough to handle. In the hard-pressed and soft-pressed tile, the shrinkage was always identical at cone 2, position 4, whereas the absorption of the soft-pressed group was always higher by 4 to 5% at this temperature. The modulus of rupture was also greater by 1500 lb. per sq. inch in the hard-pressed tile. The shrinkage of the two test sets was identical until they were fired five cones higher than their normal maturing temperature. At this temperature, the shrinkage of the soft-pressed tile was about 0.5% greater than the hard-pressed tile. This would indicate that the glassy matrix is very slow to develop until the actual fluxing state is reached. To prove further the uniform shrinkage of this body, fourteen samples were pressed, each on a different press, and all were fired at the same time. A slight size variation of only 0.009 inch in $4^1/_4$ inches occurred in the entire group, which could easily be explained by the normal variation of die sizes. Inasmuch as the maximum shrinkage tolerance at this factory is only 0.015 inch in a $4^1/_4$-inch dimension, a low shrinkage body is highly desirable.

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DRY MIXING IN THE ELECTRICAL PORCELAIN INDUSTRY*

By R. A. Snyder and J. D. Harnish

Abstract

Laboratory tests are given which establish the quality of dry-process electrical porcelain prepared by the dry-mixing process as compared with the slip method. The advantages and disadvantages of this process from an operating viewpoint are discussed.

I. Introduction

Neither the process of dry mixing nor the use of dry mixers is new. For many years, machines of this type have served in the mixing and tempering operations for heavy clay products materials and for foundry sands. The same type of machine, perhaps with some mechanical refinement, is now being used for mixing dry-process porcelain bodies. In one or two instances, the idea has been extended to the working of plastic bodies, and if this should prove generally successful, the resultant economies in the ceramic industry would be large. It seems appropriate, therefore, to review the experience of the writers in the use of the dry-mixing process and its effect on the physical properties of porcelain compositions prepared in this manner.

II. Effect of Process on Porcelain Properties

The acceptance of dry mixing as a production process in the dry-press department of this company has been based largely on engineering tests conducted on standard insulator shapes. For a more fundamental comparison of dry-mixed porcelain with that prepared by the "soak" method, however, considerable experimental laboratory work was done.

A porcelain composition used in the production of low-voltage electrical apparatus parts was selected, and a production size quantity was prepared by each of the two methods. The materials used were identical except that disintegrated ball clay and washed china clays were used in the wet method, whereas the same clays in the air-floated state were used in the dry-mixed lot. Each lot was brought to the same moisture content for dry pressing, and a number of round test bars were formed in a die mounted on a hand-operated press. Cup specimens for dielectric tests were also made. The results obtained from various tests on the two lots are given in Table I.

Table I

Method of preparation	Dry shrinkage (%)	Dry strength (lb./sq. in.)	Total shrinkage (%)	Fired modulus (lb./sq. in.)	Absorption (%)	Dielectric value (volts/mil)
Wet	2.57	216	12.2	4700	0.96	131
Dry mix	2.59	222	11.9	5100	1.00	155

These data reveal little important difference between the two lots of porcelain. The dry-mixed specimens yielded a higher fired strength and also a higher dielectric value, which may be due to denser structure brought about by more uniform dispersion of moisture in the mixing machine. Thin sections of the fired porcelains were prepared and examined under the microscope. No differences could be observed in the general structure or distribution of quartz particles.

III. Economic Advantages in Dry Mixing

With the product quality established from results of the foregoing work as being equal to that expected from bodies prepared by more conventional methods, the question arose as to what advantages exist from dry mixing to explain its rapid adoption.

There is first a considerable reduction in labor cost over the "soak" system formerly used. The dry-press clay preparation cost was $5.23 per ton, which included the preparation of the slip, filter pressing, and all additional work necessary to deliver the disintegrated clay to the press operators at the prescribed moisture content. The collection and rehandling of the scrap was also included. With the use of dry mixers exclusively in the preparation of the clay for dry-press bodies, the cost of the operation has dropped to $3.30 per ton, a reduction of 37%.

Another important advantage of dry mixing lies in better control of the moisture content of the prepared body. Under the "soak" method of preparation, this process was largely dependent on the skill of the operators and, although a skilled man developed surprisingly good judgment, the method became more and more troublesome as dimensional tolerances were reduced. With the dry-mixing process, a definite amount of water is added to each charge of new material and the moisture content of the screened clay may thus be closely controlled. This is also the case with scrap charges. The dry scrap is accumulated until a charge of normal size is available, and it is then handled through the mill in the regular way.

The adoption of the dry-mixing process has reduced the power costs by 28%.

Maintenance costs apparently have been almost eliminated. The lubrication of the machines is simple and is taken care of daily by the machine operators. Maintaining the plows and scrapers in proper adjustment is absolutely essential, and these points are checked each week by a mechanic, in addition to the daily observations made by the machine operators. Dry mixing makes possible a large economy through the elimination of wear on blunger parts, screens, pump parts, and filter sacks.

Other advantages are found in space economy and

* Presented at the Forty-First Annual Meeting, American Ceramic Society, Chicago, Ill., April 19, 1939 (Materials and Equipment Division). Received March 26, 1940.

flexibility, permitting rapid change from the preparation of one composition to another. From the standpoint of workability, the press operators report less difficulty in forming the ware, which results in a higher efficiency on this work. No improvement is apparent, however, in drying and firing losses as a direct result of dry mixing.

IV. Disadvantages of Dry Mixing

Certain disadvantages or limitations have also been encountered. The first of these lies in the cost of the raw materials. It has been found necessary to use exclusively the more expensive air-floated clays. Even with heavy mullers, a dry-mixing machine used on disintegrated ball clay or washed china clays will not deliver a product that will have suitable workability in the dry-press dies and will be homogeneous and free of spots on firing. For example, a gray dry-press body, prepared with disintegrated ball clay and fired, is badly specked with light spots of unground clay particles, regardless of the length of time of mixing. Such a body, furthermore, must either be aged or prepared with a wetting agent to develop proper workability for the more complicated shapes. The use of air-floated material eliminates these difficulties, but it increases the cost of a standard white dry-press body from $17.24 to $17.91 per ton, or 4%. Air-floated clay tends to increase the amount of dust present in the working areas of the plant, which necessitates the constant use of masks by the operators or the use of exhaust systems.

Firing losses caused by spotting have not been encountered by the writers, a fact which may be credited to the particular air-floated clays used. This defect has been a serious problem in some instances in other plants, particularly where dry mixing has been investigated as a means of preparing plastic bodies. The problem of spotting, however, may be satisfactorily overcome through the selection of the proper ball clays by the manufacturer and through the refinement of methods used by the clay producer in preparing air-floated materials.

The handling of scrap ware presents a more difficult problem as bits of foreign matter, such as wood or metal objects, must be kept out of the body to prevent damage to the machine during re-tempering. Constant vigilance is necessary to overcome this obstacle and to train the shop personnel. Although the writers encountered trouble from this source early in the use of the dry-mixing process, a satisfactory basis has been arrived at through the education of the operators involved.

V. Conclusions

A series of laboratory and design tests was made to prove that the quality of dry-process porcelain prepared by dry mixing, both mechanically and electrically, is equal to that prepared by the previously used wet methods. The advantages of lower labor costs, better control of moisture content, lower operating and maintenance costs, while partially offset by higher raw materials costs, have fully justified adoption of the dry-mixing process for dry-process porcelain manufacture.

Westinghouse Electric and Manufacturing Company
Derry, Pennsylvania

LABORATORY CONTROL OF DRAWING COMPOUNDS ON PORCELAIN ENAMEL METALS*

By D. J. Benoliel

Abstract

A series of laboratory methods is given to check drawing compounds before they are put into actual production. Complete details are given on methods which measure (1) the value of the compound as a die lubricant, (2) value as a rust preventive, (3) cleanability of the compound from a metal surface, and (4) amount of carbon and scale that remains on work after a welding process. A description is given of the apparatus, preparation of samples, methods of testing, and evaluation of results. These methods serve as a guide to give only a comparative evaluation between drawing compounds. After continued use in one laboratory, standards may be set up that will show immediately which compounds fall below a minimum given standard. Compounds that fall below this minimum standard need not be tried on a production basis.

I. Introduction

Drawing compounds to be used on work that subsequently is to be vitreous enameled must be chosen with exceptional care, owing to the various processing hazards that arise after the actual drawing of the metal. Because many compounds that could be used in the drawing of metal would cause havoc in the enameling process, any laboratory methods that can be devised to check the compounds before they are put in actual production are valuable to the enamel industry. A series of such test methods has been developed by the writer's company as well as by other firms in the country. These methods are correlated here for the first

* Presented at the Forty-Second Annual Meeting, American Ceramic Society, Toronto, Canada, April 9, 1940 (Enamel Division). Received December 22, 1939.

time, and they are presented to the industry as a basis for a series of standard laboratory methods for testing drawing compounds in all factories where porcelain enameling is done.

II. Test Methods

The methods outlined are intended to evaluate by comparison the various oil, grease, and emulsion types of drawing compounds. Pigmented compounds are excluded because they cannot be used safely for vitreous enamel and because at least one of the methods presented to test the value of the compound as a die lubricant cannot accurately measure the pigmented type of material.

The methods given herein attempt to measure (1) the value of the compound as a die lubricant, (2) its value as a rust preventive, (3) its cleanability from a metal surface, and (4) the amount of carbon and scale that remains on work after a welding process.

III. Value of the Compound as a Die Lubricant

Two individual methods have been developed to ascertain the value of the compound as a die lubricant, viz., test methods No. 1A* and No. 1B.†

(1) Test Method No. 1A

(*A*) *Apparatus:* The Olsen ductility testing machine consists of one fixed and one movable blank holder, each holder containing a 1-inch round hole in the center. A $^7/_8$-inch hardened steel ball is moved upward through the holes by means of a worm-and-gear driven punch. Pressure is measured by a strain gauge system and the cup height by an Ames gauge. Fracture diameter is measured by dividers.

(*B*) *Preparation of Samples:* Strips of sheet steel, $3^5/_8$ inches wide by 6 inches long and as near the maximum of 0.062-inch thickness as can be obtained, are selected for uniformity of gauge and of surface. Strips cut parallel to the length of the sheet are preferred to transverse sections. Slushing oils and accumulated dust are removed with solvents and rags until wiping the steel leaves no smudge on a white cloth. Marks are scribed $3^3/_4$ inches apart across the entire length of the strip. Each mark is made to coincide successively with a mark made on the test machine. By such scribing, a test strip may be removed from the machine and later may be replaced in the same position.

(*C*) *Method of Testing:* The test strip is adjusted in the machine between the two blank holders. The punch is advanced until the cup becomes 0.280 inch high. The punch is withdrawn, the strip is moved to the next registering mark, and successive cups, 0.280 nch high, are made. The odd-numbered cups, viz., 1, 3, 5, etc., are then replaced, and the punch is advanced until the dropping of the load on the strain gauge indicates fracture. The even-numbered cups, viz., 2, 4, 6, etc., after being lubricated, are likewise tested until fracture occurs. The diameters of the fractures, expressed in hundredths of an inch, are compared. The significant differences in lubricants will be evaluated when variations between fracture diameters are of the order of 0.02 inch.

(*D*) *Comments:* Thick sheet steel (approaching the machine capacity of 0.062 inch) supports a load of about 6000 pounds; differences of fracture diameters due to lubrication are more marked than in steels 0.038 inch thick which support 4500 pounds.

The height of 0.280 inch was selected as the point for lubricating because (1) the metal, locked on the ball, had attained the shape of the ball; (2) the maximum spherical area was locked on the ball; and (3) the cup was sustaining the greatest pressure per 0.070-inch increment of cup height.

Up to 0.210 inch high, the additional area derived from the original 1-inch circle was due to the general elongation with a general reduction in thickness. Between 0.210- and 0.280-inch cup height, the increase in area was attained owing to local reduction of metal thickness, i.e., a reduction of 0.003 inch at the top of the cup.

The increased height of the cup is not recommended as a satisfactory value because (1) it is difficult to stop the punch before fracture occurs; (2) when fracture occurs, the Ames gauge is not deflected the same amount each time; (3) reductions in the thickness of the nonlubricated and lubricated tops of cups are not alike; and (4) readings must be taken while the strip is in the machine. The use of lubricants on steel sheets in forming stampings in presses differs from that used in the evaluation of lubricants by this method because (1) the lubricants are applied for use during the entire forming cycle; (2) stamping is effected during a period of one second of which perhaps one-half second is used in general reduction of thickness and one-half second in local reductions in thickness; and (3) the temperature of the lubricant is elevated from 70°F. to probably 250°F. in one-half second during the stamping operation. It has been ascertained that the foregoing method is of little or no value for measuring pigmented drawing compounds owing to the size of the test machine as heretofore described.

Although pigmented compounds should not be used ordinarily in work to be vitreous enameled, it is nevertheless possible to measure the drawing value of pigmented compounds by using a 1-inch ball in place of a $^7/_8$-inch ball and a $1^1/_4$-inch die instead of a 1-inch die on the test machine. Furthermore, instead of ordinary cold-rolled steel, 18–8 metal (10 carbon, 18 chromium, 8 nickel) fully annealed should be used. This steel should have a 90,000-pound tensile strength and it should be 0.040 inch thick. This setup will support a load of 12,000 pounds instead of 6000 pounds and thus will make possible a comparative test of very heavy-duty drawing compounds such as those of the pigmented type.

* Test method 1A has been developed by P. S. Parkinson, Metallurgical Department of E. G. Budd Mfg. Co., Philadelphia, Pa., who has worked closely with the writer on many tests.

† Test method 1B has been developed by the laboratory of the Nash-Kelvinator Corporation, Grand Rapids, Mich., and is presented through the courtesy of G. W. Dykstra and L. R. Gunn.

(2) Test Method No. 1B

(*A*) *Apparatus:* A small hydraulic mounting press, equipped with pressure-arm arbors 2 inches in diameter, is used. These are undercut to provide a contact surface $^1/_2$ inch in diameter and $^1/_{16}$ inch high. Pressure is measured by a strain-gauge system. The pressure exerted on the ram of the machine is 3000 lb. per sq. in. fluid pressure. In addition to this machine, an ordinary 50-pound spring scale with a hook on each end is provided (see Fig. 1).

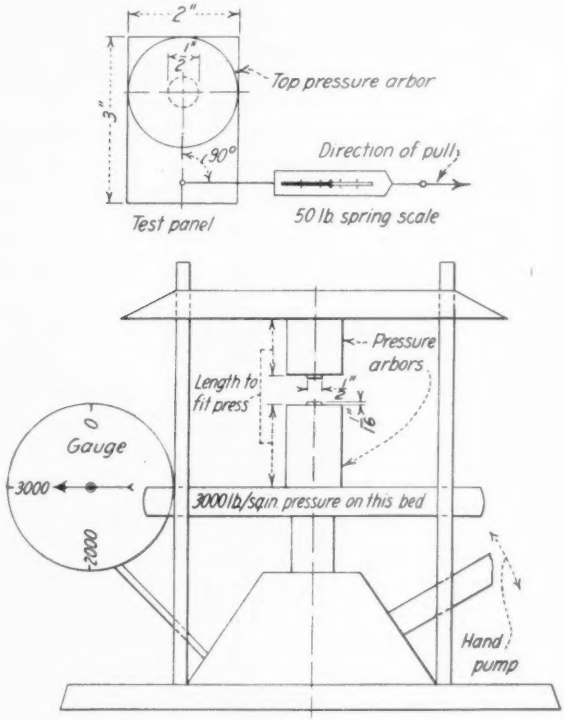


FIG. 1.

(*B*) *Preparation of Samples:* Strips of sheet steel, $3^5/_8$ inches wide by 6 inches long and as near the maximum of 0.062-inch thickness as can be obtained, are selected for uniformity of gauge and of surface. Strips cut parallel to the length of the sheet are preferred to transverse sections. A hole is punched in one end of the panel to fit the hook on the end of the spring scale. Slushing oils and accumulated dust on the test pieces are removed with solvents and rags until no smudge remains on the white cloth. The drawing compound to be tested is spread over the contact area of the test piece on both sides.

(*C*) *Method of Test:* The test piece is inserted between the contact surfaces of both pressure arbors, and the load is applied to the hydraulic system until 3000 pounds is indicated on the dial of the press. The test piece is so mounted in the press that at this point its position relative to that of the pressure arbors is at an angle of 90 degrees in the horizontal plane. The hook of the spring scale is inserted in the hole of the test panel, and the length of the scale is positioned at a 90-degree angle to the length of the test panel. The operator exerts a slow and uniform pull through the spring scale which causes a slight movement of the test panel in the direction of the pull, describing an arc.

The pull is continued through 2 or 3 inches of the arc, and the average pull on the scale is recorded. A good compound will allow the steel sample to be pulled with little effort (low scale reading), while a poor compound pulls with considerable effort (high reading), or it may stick and move only by jerks.

IV. Value of the Compound as a Rust Preventive

This method is intended to give a comparative evaluation of drawing compounds and similar types of material used to protect ferrous metallic surfaces against corrosion due to exposure to the atmosphere. It also provides for the exposure of coated panels under laboratory controlled conditions of humidity and temperature.

(*A*) *Apparatus:* The apparatus consists of a humidity cabinet, which is a box preferably lined with vitreous enamel. The size should be approximately $2^1/_2$ feet square and 3 feet high (interior measurement). The door to the box is a latch type placed on the front, similar in construction to an ordinary icebox. Inside the box is a $^3/_8$-inch brass pipe along the two sides and the rear, resting on the bottom. Holes, $^1/_8$ inch in diameter, are drilled in this pipe on the inside upper surface at an angle of 45 degrees from the horizontal. These holes are $2^1/_2$ inches apart. The brass pipe is connected with a steam line so that an even admission of steam will come from the drilled holes. A baffle plate of copper is placed around the pipe over the entrance to the holes so that the steam will not impinge with any force on pieces that may be hung in the box.

Inside the box at the top is a copper hood of conventional shape, and around the lower lip of the hood is a copper channel with a drain pipe to the bottom of the box. This hood and channel permit the steam that condenses inside the hood to drain off by means of the channel and drain pipe rather than to drop down on work that may be placed in the box. A hole, 7 inches in diameter, is in the bottom of the box, and a plate or damper is placed therein to permit the passage of cold air into the box. Another hole, 7 inches in diameter, in the rear upper portion of the box, is provided with a standard stovepipe and damper to permit the flow of air and steam through the box. Brass bars are affixed on the side of the box, about 1 inch below the bottom of the hood. Circular glass crossbars about $^1/_4$ inch in diameter rest on these ledges, and the test panels of steel are placed horizontally on these crossbars.

A hole in the upper part of the box is used to insert a rubber stopper, and a thermometer is used to gauge the temperature of the box. By proper regulation of the steam and the damper, a humidity of between 90 and 100% and a temperature from 100° to 105°F. may be maintained to which the test pieces are exposed.

(*B*) *Preparation of Sample:* The standard metal to be used is a piece of steel strip (SAE 1010), 2 by 4 inches, and gauged between 0.030 to 0.040 inch.

This piece of steel should be rubbed clean with No. 1

emery polishing paper, rinsed thoroughly in water, and placed in a boiling alkaline cleaning solution until no water-break shows on immersion in cold water. The details of this procedure are given in section V, on testing the cleanability of drawing compounds.

When the steel strip is ready for the application of the drawing compound to be tested, hot or cold dipping methods or hot or cold spraying methods may be used. Pieces should be handled with tongs or gloves to prevent moisture or acid from fingermarks. After the drawing compound is applied, the pieces are allowed to dry in the atmosphere for one hour and then are placed in the humidity cabinet on the glass crossbars. The strips should be in a horizontal position.

(*C*) *Measurement of Results:* After starting the test, the samples should be observed at intervals of 12, 24, and 48 hours and then at 24-hour intervals until rust spots or marks are distinguished on the sheet by the naked eye.

The first noticeable spot of rust marks the breakdown point of the compound. Rust will first appear on the underside of the strip.

The comparative resistance of drawing compounds to humidity and temperature may be ascertained by this test.

V. Cleanability of the Compound from a Metal Surface

(*A*) *Apparatus:* Tanks or beakers containing a standard alkaline cleansing solution are used for this test method and as many are needed as there are samples to be tested. All solutions should be made up with a standard alkali cleaner of the same concentration and at a temperature of 200°F.

(*B*) *Preparation of Samples:* The samples to be used and the process of cleaning are the same as described in section IV (*B*).

(*C*) *Method of Test:* When the steel strip is ready for the test, the drawing compound, which has been diluted either with oil or water to the consistency at which it is to be used in practice, should be applied by dipping the pieces of steel into the compound. After the application of the compound, the pieces should be dried in an oven at 175°F. for one hour and then cooled for one-half hour until they attain room temperature. To test relative cleanability of the compound, one of the test panels is immersed for 30 seconds in one of the cleaning solutions, prepared, and maintained as described. It is then removed, rinsed first in clear hot water, then in a cold 1% HCl solution, and finally in cold water to look for water-break. If a water-break occurs, it indicates that the compound has not been removed from the metal. In this case, the cleaning cycle should be repeated several times if necessary until the piece shows no water-break.

Each panel coated with a different drawing compound should be run in different alkaline cleansing solutions and at least three checks on each compound should be made to assure average results.

The comparative cleanability of the compounds may be ascertained by the method previously described.

VI. Measure of Amount of Carbon and Scale on Work After a Welding Process

(*A*) *Apparatus:* A regulation laboratory ring stand and Bunsen burner are used in this test.

(*B*) *Preparation of Sample:* Strips of sheet steel, $3^5/_8$ inches wide by 6 inches long and as near the maximum of 0.062-inch thickness as can be obtained, are selected for uniformity of gauge and surface. Slushing oils and accumulated dust are removed with solvents and rags until wiping the steel leaves no smudge on a white cloth. These strips of steel are coated on one side with a definite, weighed quantity of drawing compound, and the pieces are allowed to dry in the atmosphere for one hour.

(*C*) *Method of Test:* After the pieces have dried in the atmosphere for one hour, they are placed on the ring stand about 1 inch over a Bunsen burner, which is burning at maximum intensity. The pieces should be kept in this position until the metal is red hot, at the end of which time they are removed and allowed to cool.

(*D*) *Measurement of Results:* Samples should be observed to ascertain the amount of carbon remaining on the cold steel and to note if any unusual staining or encrustation occurs which would interfere with subsequent metal finishing or cleaning operations. This test should always be run on the new compound being tested as well as on a standard drawing compound to observe comparative results.

VII. Conclusions

The test methods presented here serve as a guide to give a comparative evaluation between drawing compounds. After continued use in one laboratory, standards may be set up that will show immediately which compounds fall below a minimum given standard. Compounds that fall below this standard need not be tried on a production basis.

After these methods have been in use for some time, the laboratory will be able to evaluate numerically the drawing compounds, giving a definite rating to each as to its worth as a die lubricant, as a rust preventive, its cleanability, and the residue left on the metal after welding.

Quaker Chemical Products Corporation
Conshohocken, Pennsylvania

CERAMIC HISTORY

BATTELLE MEMORIAL INSTITUTE

Battelle Memorial Institute began its career of industrial research in 1929, when the present main building, on King Avenue, Columbus, Ohio, became ready for use. This was six years after the death of its founder, Gordon Battelle, whose will provided for the endowment of an institution to encourage research in industry, and four years after his mother, Annie Norton Battelle, likewise left the bulk of her estate for the same purpose.

The foundry and concentration laboratories were moved in 1937 from the main building to a new building, and in 1939, construction began on a five-story wing converting the L-shaped main building into a U shape. Today the staff numbers over two hundred.

The Battelle Family in Ohio

Industrial research was comparatively new in 1923, as the country west of the Alleghenies had been to the men who came to Ohio in the years just after the Revolution. One of those pioneers was Ebenezer Battelle, III, Harvard graduate, war veteran, book-store owner, and member and agent of the Ohio Company. He brought his wife and children from Boston to Marietta in 1788, the year that town was founded, and a year later was one of the group that established the town of Belpre, a few miles farther down the north bank of the Ohio.

John Gordon Battelle, a great-grandson of Ebenezer, was a founder not of towns but of manufacturing and business undertakings. His father, a teacher and minister, died in 1862 of camp fever contracted during war service. The youth served some years in the Quartermaster Corps; after the war, he became bookkeeper and clerk in an iron-making concern and then secretary and superintendent of the Norway Manufacturing Company at Wheeling, West Virginia. A few years later he organized a new enterprise, J. G. Battelle & Company, which began the manufacture of cotton ties at Memphis.

He was married to Annie Maude Norton in Memphis in 1881, and two years later moved to Cincinnati to become manager of the Cincinnati Corrugating Company. This Company subsequently transferred its plant to Piqua, Ohio, and Mr. Battelle became its vice-president and general manager, serving as such until 1900. He was also president of the Piqua Rolling Mill Company, which, like the other, was sold in 1900 to the American Sheet Steel Company, later to be absorbed into the structure of the United States Steel Corporation.

In 1905, Colonel Battelle (the title resulting from appointment to the staff of Governor Nash of Ohio) went to Columbus to become president of the Columbus Iron and Steel Works, which was operating a new merchant pig-iron furnace on the outskirts of that city. He filled that position with marked success, and remained active in it until 1917, a year before his death, when the company and plant were sold to the American Rolling Mill Company.

Colonel Battelle was a vigorous and capable man, active not only in many business undertakings, but in political and civic affairs. It is recorded that he made the first tinplate ever manufactured in the United States. He was a director of the National Association of Manufacturers, a founder of the Ohio Manufacturers' Association, member of the American Iron and Steel Institute, and director in numerous steel- and coal-producing companies.

Gordon Battelle

Accordingly, the responsibilities falling to Gordon Battelle on his father's death were numerous and varied. He had taken an engineering course at Sheffield Scientific School, Yale University and followed that by working in several capacities at the Columbus Iron Works. He had acquired a considerable interest in nonferrous metallurgy, and at the time of the World War he organized and headed a group of zinc-mining and smelting companies in the Tri-State district.

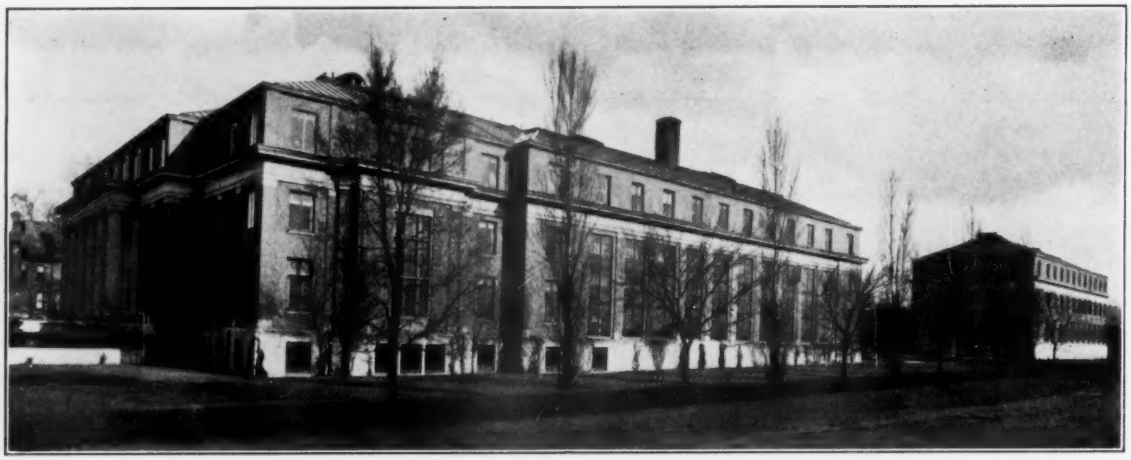
Returning to Columbus in 1918, he assumed the management of the estate, and likewise took his father's place as director of a number of steel and coal companies. He organized the International Derrick and Equipment Company, now the International-Stacey Corporation, to manufacture oil-field equipment. He held membership in the Chamber of Commerce of the United States, the Columbus Chamber of Commerce, the American Institute of Mining and Metallurgical Engineers, the American Mining Congress, and the National Metal Trades Association. He died in 1923. Throughout his career, Gordon Battelle was keenly interested in new industrial developments and, at the same time, is said to have been impressed with the need for a more general application of the scientific approach to industrial problems.

Mrs. Battelle, Gordon's mother, who had been named as one of the trustees on the endowment, died in 1925 and left a portion of her estate also to Battelle Memorial Institute, thus adding considerably to its income and the possible scope of its work.

By the end of 1929, a small group of men were at work on a handful of research projects in the new laboratories, and the enterprise founded by Gordon Battelle was finally under way.

Plan for Industrial Research

Battelle Memorial Institute is a corporation not for profit, organized under the laws of Ohio. A large portion of its endowment income is devoted to fundamental research on subjects of general industrial concern. Another considerable share of these funds goes to educational activities. As research associates, a number of young men each year are given training in research methods, working on fundamental investigations. Three scholarships are maintained at Ohio State University under an arrangement by which the student does his thesis work at the Battelle Laboratories, where it is supervised and administered as a regular research project. Other educational features of staff members comprise the preparation of technical papers,



The buildings of the Battelle Memorial Institute viewed from the northwest

technical committee work, and talks before industrial, technical, and scientific groups.

The greater part of the Institute's work, however, consists of research on problems brought to it by private industry. Such work is paid for by the sponsor, and the results belong to the sponsor. The permanent staff is employed on it just as on Battelle work, and it is supervised similarly by the heads of the research divisions. The service departments such as the chemical and physical laboratories, the library, drafting department, and the shops, likewise are available to all research projects. By thus accepting privately sponsored research projects, it has been possible to improve research facilities and build up the staff far beyond the limits possible on an endowment income.

A self-perpetuating six-member board of trustees handles investments and deals with matters of general policy. The Director is responsible to the board for the management of the organization. In this, he is assisted by a supervisory and administrative staff in charge of fifteen specialized research divisions and a number of service and administrative departments.

Research Limited to a Few Fields

The Institute's fields of work are, broadly, ceramics, metallurgy, minerals preparation, fuels, physics, and chemistry. Subdivisions are physical metallurgy, foundry and process metallurgy, steelmaking and alloy steels, nonferrous metallurgy, creep testing, physics and physical properties of metals, corrosion, electroplating, fuels, combustion, carbonization of coal, coal preparation, ore dressing and concentration, and fundamental and industrial chemistry.

Personnel, Ceramics Division

Clyde E. Williams, Assistant Director of the Institute from 1929 to 1934 and Director since then, initiated its research in ceramics. Work is carried out in refractories glass, enamels, pottery, whiteware, lime, cements, and, heavy clay products. Mr. Williams is the author of papers on metallurgical refractories and on the use of metals in the ceramic industry. He is a member of The American Ceramic Society and an associate member of the American Refractories Institute.

J. D. Sullivan, a member of the supervisory staff since 1931, heads the group of engineers engaged in ceramic research. His work on refractories has made him an authority in the field, and he has made valuable contributions in other divisions of ceramics, including recently a fundamental investigation with R. P. Graham, research associate, of the effect of exchangeable bases on workability characteristics of clay bodies. He is a Fellow of The American Ceramic Society and chairman of its Publications Committee, a member of the British Ceramic Society, the Society of Glass Technology, and the Deutsche Keramische Gesellschaft. In the American Society for Testing Materials, he is chairman of the Refractories Committee.

C. R. Austin is assistant supervisor of ceramic research. He joined the Battelle staff in 1934, after several years of experience as research engineer with the Ohio State Engineering Experiment Station and as construction engineer with the Ohio Fuel Gas Company. He has been closely associated with the development of the deairing process of clay-products manufacture and has written on this and on other investigations, including studies in glazes, barium hydroxide as a scum preventive, and Ohio clays and shales. He is a Fellow of The American Ceramic Society.

Research engineers in the ceramic division are S. J. Brooks, G. H. Duncombe, E. M Lannes, T. E. Pochapsky, E. J. Rogers, S. L. Santomieri, R. B. Snow, and P. F. Wacker. M. W. Doyle and E. T. Doyle are technical laboratory assistants.

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CHINESE CERAMICS AT THE BALTIMORE MUSEUM OF ART

By Edward S. King

Examples of Chinese Ceramics in Baltimore

In its recent acquisition of some twenty-two pieces of early date from the estate of the Baltimore collector, the late William H. Whitridge, the Baltimore Museum of Art has taken its first independent step toward forming a collection of Chinese ceramics. Prior to this fortunate move, the Museum had been able to show a number of K'ang Hsi blue and white porcelains of excellent quality, the gift of the late Francis B. Harvey, and some pieces of considerable interest, mostly of the T'ang and Sung periods, loaned by Dr. Chao Ming Chen of Baltimore, while James R. Herbert Boone, also of this city, has loaned a number of T'ang funerary figurines and Ralph Chait of New York has donated a large and impressive Tz'u Chou jar. The Whitridge pieces were acquired through the Julius Levy Memorial Fund, founded by his brothers, William and Alfred Levy, and added to by his widow, the income from the Fund being devoted to the acquisition of Oriental works of art.

Heretofore Chinese ceramics on public view in Baltimore has signified, nearly exclusively, the collection in the Walters Art Gallery. Almost everyone knows of it who has a catholic interest in the subject. One can say this, thanks largely to the fact that William T. Walters secured Stephen W. Bushell, physician to the British Legation at Peking, to write a full and scholarly account of Far Eastern ceramics fashioned around and illustrated by specimens in the Walters collection. Bushell's work, Oriental Ceramic Art, of which there were published an illustrated edition limited to five hundred copies in ten folio volumes in 1897 and a one-volume, unillustrated edition in 1899 is the great landmark on the subject in modern times. It combined first-hand experience in the Far East, a thoroughgoing knowledge of the Chinese literature (contrasted with a superficial knowledge of the Japanese), and what had been accomplished by western students. It became the standard and authoritative text for subsequent writers. This engrossing work and the collection it illuminates, however, do not form the subject of the present remarks, which is to call to the attention of those concerned what transpires in the field at Baltimore's other museum of art.

General Plan of Museum Collection

The Baltimore Museum's general plan for building up its section of Chinese ceramics is determined by three intelligible considerations, (1) a high qualitative level, (2) examples representative of the principal developments in the history of the subject, and (3) the intention, at least for a number of years to come, not to duplicate by purchase the material already available at the Walters Art Gallery. The first consideration as to quality is a self-evident desideratum; and, insofar as the rare piece is concerned, it will be seen from at least two items garnered from the Whitridge sale that rarities may sometimes come the Museum's way. The second consideration as to inclusiveness means that the Baltimore Museum is interested ultimately in presenting the subject of Chinese pottery and porcelain as a whole and in a way to interest all classes of its public—its discussion groups, the casual spectator, and the students preoccupied with matters of technique and form, the last group at present comprising the students of the Maryland Institute and a few individual practitioners. Thirdly, the extensive Walters collection—which William T. Walters began about 1860, a date that must place it among the first deliberately planned collections of Far Eastern ceramics in America—is composed largely of the ware of the 17th and 18th centuries associated with the names of the Emperors K'ang Hsi, Yung Cheng, and Ch'ien Lung. And while the Walters Chinese ceramics, with nearly two thousand pieces to choose from, offers some excellent examples from the periods of the Mings and the Sungs, it lacks many types and techniques produced in their times, and the collection becomes progressively sparser as one looks back through the periods of T'ang and Han and beyond. It is to be recalled that it is only in the last quarter-century or so that archeology and taste combined to give the ware of the earlier epochs careful attention and a well-deserved appreciation. The Baltimore Museum has in consequence wisely decided not to compete with the material in which the Walters Gallery is well off but to concentrate on the ware of the earlier periods heretofore inadequately represented in the City's public collections. And such is the scope, the great variety, and the complexity of the subject that the two collections can continue to supplement and complete each other for many years to come.

Collections of Interest to The American Ceramic Society

It is to the point to mention that the wide range of the Walters ceramic collection generally—Egyptian, Greek, Roman, Persian, and the various productions of the West as well as the Chinese—has proved a great attraction to the Art Division of The American Ceramic Society and to The Society itself in the decision to hold its Forty-Third Annual Meeting at Baltimore from March 30 to April 5, 1941. The members will again be able to view the Walters exhibits as well as the now-improved Chinese showing at the Baltimore Museum.

The collection of Chinese potteries and porcelains formed by William H. Whitridge numbered well over four hundred pieces and it was notable among private collections for the completeness with which it covered the various developments of Chinese ware, from neolithic pots to a canary-yellow beaker with the mark and motto of the Manchu Empress Dowager, Tsz'e Hsi, who died in 1908.[1]

Certainly the greatest rarity in this array is the finely turned out baluster-shaped vase in monochrome green, now the property of the Baltimore Museum (Fig. 1). Those readers who have the collector's point of view or who have been conditioned by the peculiar sensuous de-

[1] The majority of the Whitridge pieces figured in an exhibition held at the Baltimore Museum of Art, June 1 to October 15, 1930, for which a complete and scholarly catalogue, entitled Orientalia, was written by Ralph M. Chait. The sale of the Whitridge collection took place on November 16 to 18, 1939, at the Parke-Bernet Galleries, New York. The yellow beaker referred to is No. 518 in the sale catalogue.

lights to be derived from Chinese ceramics will be readily able to imagine the peculiar interest of this vase and of the others described herein. For those unbitten and oblivious, a reproduction in black and white can add but little to so many words. This Ming piece, with the *nien hao* of the Emperor Wan Li (1573–1619) on the lip in blue on a white reserve, would have to be highly ranked in any collection by virtue of its artistic quality as well as because of its rarity. And particularly is this true today if we may judge from the present demand for just such Ming ceramic qualities as are so excellently displayed here. This unusual specimen was formerly in the J. Pierpont Morgan collection, which owned also a slightly smaller and somewhat less brilliantly colored fellow to it.[2] The porcelain body, grayish and not overly refined in texture, is thick, and all over it, apparently, has been flowed a glaze of tallow-like whiteness. Upon this was spread the unctuous green glaze with plays of iridescence that gives the vase its principal distinction. This glaze was described in the catalogue of the Morgan collection as "apple-green," and as an adjective the term is doubtless as apposite as any short of scientific terminology. It should be noted, however, that this glaze of a soft, creamy-looking consistency is quite distinct from the two glazes customarily referred to under the heading of apple-green, both in regard to technical procedure and in appearance.[3] Its smooth, icing-like swirls, very appreciable on close view, show that it is similar in character to the green enamel familiar on *famille verte* porcelains, and doubtless it is a comparable glaze. Its unevenness of flow gives the surface of the vase slight changes of hue, a certain variety of interest, and a handmade, spontaneous touch that is so characteristic of most Ming ware in contrast to the formal precision of 18th century designs. Casual too, but full of character, are the faintly brushed-in floral decorations discernible on the green field; above and below the ridge separating the shoulders from the body proper are grape vines with fruit, tendrils, and large leaves; above appear chrysanthemums and plum blossoms; below are lotuses and another fruit blossom with five-pointed petals, the two fields being delimited by cloud scrolls. As a finishing touch, a very thin, transparent glaze has been applied over the whole and this is faintly crackled. From a scrutiny of this vase, one gets the clear impression that its maker was following a familiar procedure from start to finish and that he accomplished the various steps of the making with an easy mastery.

FIG. 1.—Baluster vase in monochrome green, an unusually fine specimen of Ming porcelain (*Baltimore Museum of Art*).

FIG. 2.—Sung ceramics: *left*, Chün ware vessel in form of incense burner; *center*, Lung-ch'üan celadon jar; *right*, Ting ware oil lamp (*Baltimore Museum of Art*).

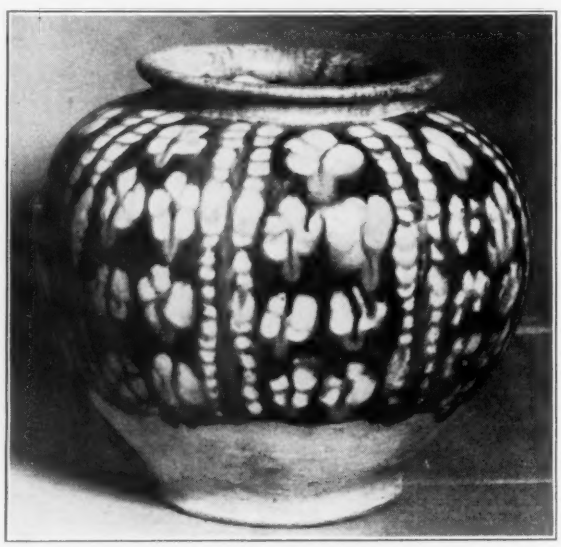


FIG. 3.—T'ang earthenware jar with lead-silicate glaze worked in floral patterns (*Baltimore Museum of Art*).

The three classic wares of the period of the Sungs (960–1279)—Ting, celadon, and Chün—are represented by a number of pieces acquired from the Whitridge collection, of which the three most interesting are reproduced in Fig. 2. Ting ware, which derives its name from Ting Chou in Chihli province and which may have originated in the

[2] No. 313 in Chait, Orientalia; No. 487 in the Parke-Bernet sale catalogue; No. 1515 in Vol. II (1911) of the Catalogue of the Morgan Collection of Chinese Porcelains. The companion piece will be found in Vol. I (1904) of the Morgan Catalogue, No. 16, Case H, Pl. LXI.

[3] These two glazes are described by R. L. Hobson, Chinese Pottery and Porcelain (New York and London, 1915), Vol. II, as follows: (1) p. 102, Pl. 85; p. 125, "apple-green," an uncrackled brilliant emerald or apple-green enamel glaze over a crackled greenish-gray or stone-colored glaze, commonly called *lang yao* green. The technical procedure here is different from that employed on the Baltimore vase in having a crackled greenish-gray underglaze, and the resultant tone is also different as a comparison would show; (2) pp. 125, 177, 188, the true *lang yao* green; a highly translucent (high-fired) glaze full of bubbles, like the red *lang yao* or ox-blood. The latter glaze is described by the Chinese as apple-red (*p'in-kuo hung*) and its green markings as apple-green (*p'in-kuo ch'ing*).

T'ang dynasty,[4] is seen here in an unusual form, a two-part oil lamp, being a delicate foliated bowl on a flanged stand. There is a Ting-ware lamp of similar shape in the Metropolitan Museum, New York, and another in the Eumorfopoulos collection of the British Museum.[5] The body is of grayish-white porcelain which is covered with a warm ivory-white glaze; the uncommonly deep russet tone of the crackle, which gives an effect of age and mellowness, is very probably the result of long burial.

Celadon, and more particularly the type that takes its name from the district of Lung-ch'üan in Chekiang province, is the most familiar of early Chinese porcelains and it was long famous as an article of export to Persia, Egypt, and India. Of this type, the dragon-jar illustrated is characteristic in every respect, from the heavy, grayish near-porcelain body with reddish-brown stains occasioned by iron in the clay to the light grass-green glaze of the petalled base changing to a soft gray-green on the cover. The Chinese call celadon *ch'ing tz'u*, meaning green porcelain, and for obvious reasons they often compare its beauties to those of jade.

FIG. 4.—*Left*, Han glazed tripod bowl; *center*, primitive type caldron-like vessel; *right*, neolithic bowl (*Baltimore Museum of Art*).

Chün, the third type of Sung ware referred to, received its name from Chün Chou in Honan. It is usually remembered by those vessels with glorious lavender-gray splashed-with-purple glazes, which a Chinese writer of the late 16th century lists with its popular label of "donkey's liver and horse's lung."[6] The Baltimore vessel in the form of an incense burner supported on the interpenetrating bodies of three rams has a much quieter hue. Over the brownish porcelanous paste there is an olive-brown glaze with darker spots and upon this is an overglaze running from blue to creamy-buff and dull lavender, both glazes finely crackled. It gives a clear idea of those furnace transmutation effects in glazes that gave rise to a whole class of porcelains in the 18th century and which Chinese writers call *yao pien*. It is said that there are only four other vessels known of the type of the Baltimore incense burner.[7]

The modesty of material and peculiar fresh earthiness of the colors of T'ang potteries obtain typically in a jar of light buff earthenware (Fig 3). The rich amber-brown, leaf-green, dull sulfur-yellow, and white of the thin, finely crackled glaze are never seen in just this quality of color save on the ware of the T'ang dynasty (618–906). Shades of the same category are well remembered on those magnificent figures of Lohans, one of which is in the Museum of the University of Pennsylvania, the other in the British Museum. The several colors on the jar are due to the dabs or washes applied to the biscuit; over them was flowed a transparent (lead-silicate) glaze of a slightly yellowish tint, which absorbed the colors without however disturbing the floral designs. The result is an integral effect and of one color changing insensibly into another, especially notable in the effortless way in which the white flowers seem to emerge from the green ground. In this achievement, the modern craftsman as well as the collector should find much to whet his interest.

Of a type dating from neolithic times is the three-legged vessel with the deep markings of a coarse fabric impressed upon it (Fig. 4). This type continued to be made in the Chou dynasty (1122–255 B.C.), to which period some authorities indeed assign the Baltimore tripod, whose form recalls the Chou bronze caldrons (*li* and *ting*).[8] It would be difficult to imagine a more expressive sort of primitive pottery than this heavy unglazed vessel. The walls are thick, hard, gray clay, and its form suggests the still more primitive use of goatskins, a copying of natural forms repeated in the "mat-marking" (to indicate goat hair?). Likewise attributed to the new stone age in China, but representing a more advanced stage of development in its skeuomorphic design, is the bowl of buff earthenware. Here the painted patterns of diamond and trelliswork in dark brown separated by vertical bands of dark red are reminiscent of wattled and woven construction.

An event of the first importance in Chinese ceramic history is illustrated by the Han three-legged covered bowl, namely, the introduction of glaze (Fig. 4). It may be that glazed pottery was made in China before the Han dynasty (206 B.C.–A.D. 220), but the earliest known glazed objects from China are to be dated in that period.[9] On the practical plane, the appearance of glaze rendered porous earthenware vessels suitable to contain liquids, while aesthetically there now begins that long and endlessly varied development which makes Chinese pottery and porcelain the fascinating subject it is. The tripod vessel, obviously derived from a bronze *ting*, has the typical tone of the finely crackled Han glaze, a dull leaf-green shading to buff. The reddish earthenware tends to add to the warm effect. The glaze is modified considerably by iridescent encrustation resulting from the long period of burial.

[4] R. L. Hobson, Eumorfopoulos Collection, Catalogue of the Chinese, Corean, and Persian Pottery and Porcelain, Vol. III (London, 1926), p. 18.
[5] R. L. Hobson, *op. cit.*, Vol. III, Pl. XLI, C 237.
[6] R. L. Hobson, *op. cit.*, Vol. III, p. 1.
[7] R. M. Chait, Orientalia, No. 412.
[8] R. M. Chait, *op. cit.*, No. 635; H. Th. Bossert (ed.), Geschichte des Kunstgewerbes, Vol. III (Berlin, 1930), pp. 14–15; R. L. Hobson, Handbook of the Pottery and Porcelain of the Far East, British Museum (London, 1937), p. 1.
[9] R. L. Hobson, Chinese Pottery and Porcelain, Vol. I, p. 89; R. L. Hobson, British Museum Handbook, p. 5.

It Is Only by Communication with Others That Knowledge Is Acquired; Membership in The American Ceramic Society Is Opportunity for This Achievement

UNIVERSITIES ANNOUNCE 1940 CERAMIC HONORS AND DEGREES

Missouri School of Mines and Metallurgy

Doctor of Engineering (Honoris Causa): F. W. GREEN, Vice-President, Cotton Belt Railroad.

Degrees in Ceramic Engineering

Bachelor of Science in Ceramic Engineering: JOSEPH LEWIS HOFFMAN (Mexico Refractories Co.), IVAN MARTIN NIEDLING (Acme Brick Co.), SIDNEY AUSTIN PEER, THEODORE J. M. PLANJE, EVERETT WALTER SHARP (Mexico Refractories Co.), and WILLIAM JOSEPH SMOTHERS.

Mr. Smothers received first honors and was elected to Phi Kappa Phi and Tau Beta Pi. He will continue his work on a Missouri School of Mines Fellowship.

Mr. Planje will continue his studies on a Massachusetts Institute of Technology Fellowship.

Allen P. Green, Sr., Awards

A scholarship for the senior year and a medal and cash award upon graduation are contributed by Allen P. Green, Sr., president of the A. P. Green Fire Brick Company, Mexico, Mo. Each is awarded to a student with an outstanding record in scholarship, character, and leadership. Walter Philip Leber received the scholarship of three hundred dollars for his senior year, which was awarded in June, 1939. The medal and cash award, based on four years' work, was presented to Powell Arthur Dennie.

Research During Summer Months

The summer school of the University presents only basic courses for engineers.

Paul G. Herold, Head of the Ceramic Engineering Department, will work with the Missouri Geological Survey on two problems, namely, (1) "Separation and Use of Feldspar from Missouri Granites," and (2) "Ceramic Possibilities of Southeastern Missouri Clays."

West Virginia University

Master of Science in Chemical Engineering: (1) EDWARD ECKERT, Morgantown, W. Va.; (2) JAMES C. GOODWIN, Celanese Corp., Cumberland, Md.; (3) J. D. MCFARLAND Westvaco Corp., South Charleston; (4) JOHN NUZUM, E. I. du Pont de Nemours & Co., Jackson Lab., Wilmington, Del.; (5) J. W. PHELPS, West Virginia Pulp & Paper Co., Piedmont; and (6) HAROLD PRATT, American Viscose Corp., Parkersburg.

Bachelor of Science in Chemical Engineering (Courses in Ceramics): (1) WILLIAM ARMSTRONG, Walkersville; (2) SAM AUDIA, Charleston; (3) SILAS BENSON BIRCH, Wheeling; (4) FREDERICK AUSTIN DUDDERAR, Morgantown; (5) J. WALTER DUDROW, Harpers Ferry; (6) ROBERT EDWIN FLEMING, LeRoy; (7) LEONARD JONES GOODSELL, Morgantown; (8) KENDALL LEON HALL, Harrisville; (9) BEVERLY M. HIGGINBOTHAM, JR., Spring Hill; (10) CLARIO NEAL JIMISON, Logan; (11) BEN S. JOHNSON, JR., Bluefield; (12) FREDERICK WILLIAM LANG, Morgantown; (13) ROBERT E. LEE, Dunbar; (14) GEORGE GOETHALS MEGRAIL, Morgantown; (15) WYLIE BEALL MENDEL, Wellsburg; (16) OTIS ULYSSES NICHOLS, Hiawatha; (17) VICTOR LETTORINE PANTALONE, Farmington; (18) CHARLES MARCUS REED, Martinsburg; (19) AARON ROSE, Morgantown; (20) HENRY W. SCHWEINSBERG, Plus; (21) JOHN LEE SULLIVAN, Uniontown, Pa.; (22) MAXWELL DANA HARVEY, Belle; (23) HERBERT NORRIS JOHNSTON, Morgantown; (24) ANDREW PSALIDAS, Martinsburg; (25) DEEM FRANK RAHALL, Beckley; and (26) JOSEPH ARNOLD SCHERR, Keyser.

New Mineral Industries Building

W. A. Koehler, Acting Head, Department of Chemical Engineering, states that money has been released for the new Mineral Industries building to house the State Geologic Survey, the Department of Geology, School of Mines, and the Department of Chemical Engineering, including its Division of Ceramics.

Two large laboratories are supplied especially for ceramics and, in addition, all the facilities of the Chemical Engineering Department will be available to students specializing in ceramics. The building, when completed, will cost approximately $750,000 without equipment. The architects are now working on the details of the building and construction is to start in the early fall.

University of North Carolina

Master of Science in Ceramic Engineering: J. J. AMERO.

Bachelor of Science in Ceramic Engineering: S. W. DERBYSHIRE, C. M. GATTIS, JR., C. W. ISENHOUR, JR., R. P. MCCABE, W. S. MCLAUGHLIN, H. F. RANDOLPH, G. C. ROBINSON, F. P. SABOL, J. N. SMITH, JR., and E. A. WILLIAMS, JR.

Fellowships and Research Work

Hal Randolph, Tau Beta Pi fellow, will attend Ohio State University next year.

J. N. Smith, Jr., will be the Bureau of Mines fellow at the University of Alabama.

R. P. McCabe has been appointed a fellow in the Department of Ceramic Engineering at the University of North Carolina.

W. W. Kriegel will do petrographic research on olivine for the Tennessee Valley Authority this summer, and A. F. Greaves-Walker will conduct tests on the same mineral for the Norris Station of the U. S. Bureau of Mines.

Iowa State College

Bachelor of Science in Ceramic Engineering: KEITH D. BARTELS, LeMars; KEITH B. CHANDLER, Sigourney; MORRIS W. GORMLY, Mount Vernon; VERNON L. PLAGGE, Barrington, Ill.; CLIFFORD V. SCANTLEBURY, Hampton; THOMAS J. TAYLOR, Waterloo; and OSGOOD J. WHITTEMORE, Fort Dodge.

Plans for Summer Months

C. M. Dodd, Head of the Department, states that during the summer months work will be directed toward the development of vitreous slip coats for Iowa red-firing clays. Although this is not a new problem in the sense of fundamentals, it may be to some advantage to the industry of the State.

Virginia Polytechnic Institute

Master of Science in Ceramic Engineering: J. P. SAWYER, JR.

Bachelor of Science in Ceramic Engineering: J. A. BAILEY, JR., H. A. DESAIX, W. H. HITT, R. A. MOFFETT, O. J. PARKER, L. A. RHOADES, E. H. ROLLFS, and L. M. SHOWALTER.

Summer Work

J. W. Whittemore, professor in the Ceramic Engineering Department, states that the various research projects that have been carried on for a considerable time will be continued during the summer. Summer school courses also will be offered.

University of Washington

Professional Degree of Ceramic Engineer: KENNETH GUY SKINNER (M.Sc., Washington, '33).

Master of Science in Ceramic Engineering: JOHN WILLIAM BELL (B.Sc., Washington, '38).

Bachelor of Science in Ceramic Engineering: KENNETH LEON MCBREEN and NORMAN BORIE WAYLAND.

Mr. Wayland received his degree in March, 1940.

The Pennsylvania State College

JUNE, 1940, GRADUATES IN THE DEPARTMENT OF CERAMICS

Name	Home Address	Degree	Thesis Topic	Employment
(1) William R. Cramer	1251 W. Princess St., York, Pa.	B.S.	"Use of Silicyl Phosphate in Whiteware Body"	Sauereisen Products Co., Sharpsburg, Pa.
(2) John F. Green	116 Walnut St., Hollidaysburg, Pa.	B.S.	"Beneficiation of a Face Brick Clay by Froth Flotation"	Dept. of Ceramics, Penn State College
(3) James P. Poole	257 E. Fulton St., Butler, Pa.	B.S.	"Use of Phosphate Glasses as Fluxes in Whiteware Bodies"	Hygrade-Sylvania Co., Emporium, Pa.
(4) Alfred Post	1714 Fallowfield Ave., Pittsburgh, Pa.	B.S.	"Development of Certain Colored Tile Bodies"	Universal Sanitary Mfg. Co. New Castle, Pa.
(5) Roger F. Scott	714 East Green St., Waynesburg, Pa.	B.S.	"Development of Very High Silica Glasses"	Armstrong Cork Co., Lancaster, Pa.
(6) Bruce F. Trumm	637 Park St., Honesdale, Pa.	B.S.	"Development of Very High Silica Glasses"	Owens-Illinois Glass Co., Clarion, Pa.
(7) William A. Scholes	18930 Littlefield Ave., Detroit, Mich.	M.S.	"Removal of Iron-Bearing Minerals from Ceramic Raw Materials by Froth Flotation"	Dept. of Ceramics, Penn State College
(8) Paul M. Corbett	1976 Vyse Ave., New York, N. Y.	M.S.	"Melting of Homogeneous Refractory Surfaces by Various Molten Glasses"	Dept. of Ceramics, Penn State College
(9) Arthur E. Williams*	1896 Delhi St., State College, Pa.	M.S.	"Reducibility of Silver, Copper, and Bismuth in Different Basic Glasses"	Fostoria Glass Co., Moundsville, W. Va.
(10) Folsom M. Veazie	Avoca, N. Y.	M.S.	"Influence of Tin on Ruby Glasses"	Owens-Corning Corp., Newark, Ohio

* Mr. Williams is the only M.S. candidate to complete his work in time for the June Commencement. The other men will finish their work during the summer and will receive the Master of Science degree early in August.

Ohio State University

Lammé Medal Award

LAWRENCE E. BARRINGER (E.M. in Ceramics, 1902; Professional Degree, 1933), General Electric Co., Schenectady, N. Y.

Professional Degree of Ceramic Engineer

(1) ROBERT H. ANWYL (B.Cer.E., 1928), Superintendent, Harlem Farm Brick Plant, Richmond, Texas.

(2) JAMES R. BEAM (B.Cer.E., 1930), Universal Sanitary Mfg. Co., New Castle, Pa.

(3) ARTHUR J. BLUME (B.Cer.E., 1927), Square D Co., Peru, Ind.

(4) EDWARD E. CALLINAN (B.Cer.E., 1930), Timken Steel & Tube Co., Canton.

(5) WILLARD K. CARTER (B.Cer.E., 1930), National Aluminate Corp., Chicago, Ill.

(6) WARREN F. COPP (B.Cer.E., 1930), Wheeling Steel Corp., Wheeling, W. Va.

(7) EMERSON W. EMRICH (B.Cer.E., 1929), R. T. Vanderbilt Co., New York, N. Y.

(8) WALTER D. FORD (B.Cer.E., 1930; M.Sc., 1931), Ford Ceramic Arts, Inc., Columbus.

(9) T. WALTER GARVE (B.Cer.E., 1929), 314 King Ave., Columbus.

(10) JOHN F. HUNT (B.Cer.E., 1930), Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

(11) RICHARD O. LANE (B.Cer.E., 1930), Macklin Co., Jackson, Mich.

(12) JOHN L. MOSER (B.Cer.E., 1930), Simonds-Worden-White Co., Dayton.

(13) STEPHEN T. SPIRES (B.Cer.E., 1930), North American Refractories Co., Womelsdorf, Pa.

Ohio State University Student Branch, The American Ceramic Society, 1940
(Seated) faculty and seniors; *(standing)* juniors and some sophomores.

(14) HARRY W. THIEMECKE (B.Cer.E., 1930; M.Sc., 1931), Homer Laughlin China Co., Newell, W. Va.

(15) CHARLES E. WEBSTER (B.Cer.E., 1930), Lava Crucible Co., Zelienople, Pa.

(16) NORMAN G. WEDEMEYER (B.Cer.E., 1930), Röhm & Haas Co., Philadelphia, Pa.

Other Degrees

Master of Science in Ceramic Engineering: JO M. TEAGUE, JR. (B.Cer.E., Georgia School of Technology, Atlanta, Ga., 1939), Columbus.

Bachelor of Science in Ceramic Engineering: (1) ESTHER S. AMOS, Bowling Green; (2) JAMES F. BARNS, Shaker Heights; (3) JAMES M. BLACKWOOD, Columbus; (4) ROLAND C. BURT, Avalon, Pa.; (5) ROGER C. COOPER, Wickliffe; (6) REGINALD J. HENWOOD, Shaunavon, Saskatchewan, Canada; (7) MAX W. HOELSCHER, University Heights; (8) RICHARD P. KELTING, Toledo; (9) JOHN W. LENNON, Columbus; (10) CHARLES V. MYERS, Springfield; (11) RUSSELL C. NEFF, Pittsburgh, Pa.; (12) ROBERT L. NEWTON, Cleveland; (13) HARRY PAPIER, Columbus; (14) HOWARD E. PETTY, Amherst; (15) ALFRED W. ROBINSON, Boliver, Pa.; and (16) PHILIP W. TEFFT, Columbus.

High Scholarship in 1939–1940

Arthur S. Watts, professor in the Department of Ceramic Engineering, states that the year 1939–1940 has been especially successful in the Department, and there are indications that the seventeen graduates will be employed before July 1. The quality of scholarship is steadily improving.

The grade average of the entire senior class is above the standard required by Ohio State University, the University of Illinois, and the New York State College of Ceramics for admission to Keramos, which at these schools is recognized as an honorary scholastic fraternity.

New York State College of Ceramics

Charles Fergus Binns Medal

This Medal award was given to WAYLAND GREGORY, ceramic sculptor, New York, N. Y.

Degree of Ceramic Engineer

GRANT S. DIAMOND, Electro Refractories & Alloys Corp., Buffalo, N. Y.

Other Degrees

Bachelor of Science in Design: (1) SANDFORD L. ARKIN, Brooklyn; (2) STANLEY S. BALLARD, Hornell; (3) ELIZABETH ANNE CURTIS, Rochester; (4) JOSEPH S. CUTRONA, Silver Creek; (5) EILEEN DAVIS, Poughkeepsie; (6) ELEANOR ELIZABETH DRAKE, Oswego; (7) ALICE MARGARET FLANNIGAN, Geneva; (8) SHELDON B. GANTS, Sunnyside; (9) BRUCE C. GILBERT, Adams Center; (10) GEORGE H. JOHNSTON, Ellicottville; (11) SUSIE PAULINE KOHL, Hammondsport; (12) WILLIAM R. MARONEY, New York; (13) HAROLD D. MYERS, Thornwood; (14) AWNY J. OHMITIE, Sea Cliff; (15) JANET ESTELL ROGERS, Ithaca; (16) BETSY BURR RYDER, Fairport; (17) CHARLES W. SHOEMAKER, JR., Olean; (18) VERA BERENICE SMITH, Washington, D. C.; (19) MARY ELIZABETH VAIL, Vernon; (20) JANE LUCY WALKLEY, Conesus; and (21) FRANCES DE WITT WASHBURN, Alfred.

Bachelor of Science in Glass Technology: (1) ROBERT W. BENNETT, JR., New York; (2) WAYNE E. BROWNELL, Hornell; (3) CHARLES C. CASAMO, Patterson; (4) STEPHEN P. DAY, Poughkeepsie; (5) WILLIAM C. DROHAN, Yonkers; (6) DONALD D. FAULKNER, Bellerose; (7) HENRY MOORE, Great Neck; (8) DONALD S. NESBITT, Hornell; (9) ANNE CATHERINE PAKULA, Brockport; (10) EDGAR J. ROOK, JR., Medina; (11) THEODORE S. STANISLAW, Freeport; and (12) EDWIN W. WESSELS, Avoca.

Bachelor of Science in Ceramic Engineering: (1) FRANK CHARLES ARRANCE, Alfred; (2) DON W. BISSELL, Hamburg; (3) EDWARD JAMES BLAND, Niagara Falls; (4) ANGELO D. BOSCO, Pleasantville; (5) ROBERT L. BROWNELL, Dunkirk; (6) GEORGE M. COLUCCI, Westhampton Beach; (7) WESLEY E. CURTIS, Westfield; (8) WALTER R. DLUGOZIMA, Westhampton; (9) LESLIE L. DOY, Syracuse; (10) SAMUEL A. FOSSACECA, Elmira; (11) TERRY STEPHEN GALANIS, Buffalo; (12) BERNHARD F. GENTSCH, Oakfield; (13) RAYMOND P. GREENMAN, Portville; (14) WALTER A. HEDDEN, Alfred; (15) MALCOLM P. HILL, Medina; (16) THEODORE J. IENCZEWSKI, Sherrill; (17) NORMAN KENDALL, West Valley; (18) WILLIAM P. KUNES, Gallupville; (19) FLOYD A. OLIVA, Walden; (20) WILLARD D. PACKMAN, Akron; (21) HOLLIS S. SAUNDERS, East Rochester; (22) DAVID W. THOMAS, Elmira; (23) EVERETT A. THOMAS, Almond; (24) JAMES A. THOMAS, JR., Niagara Falls; (25) KENNETH T. WOOD, Hornell; (26) ROBERT W. WOODRUFF, Naples; and (27) RAYMOND R. ZURER, Brooklyn.

Plans for Summer Months

Major E. Holmes, Dean of the College, states that the Ceramic Experiment Station will carry on the same research work during the summer as it does during the winter. Various members of the teaching staff will also be doing some research work.

The Summer School will be in progress as usual, but practically all of it is devoted to ceramic art and pottery. This ceramic art summer course has proved to be very popular. More students, however, could be accommodated.

University of Alabama

May Graduates

Bachelor of Science in Ceramic Technology: EARL A. McCOY and EDWARD P. FORST.

Both Mr. McCoy and Mr. Forst are planning to do graduate work next year.

Department of Ceramics

The Department of Ceramics at the University of Alabama, with T. N. McVay in charge, operates as a division of the School of Chemistry, Metallurgy, and Ceramics. It was organized in 1928 with Stewart J. Lloyd as Dean of the School.

The curriculum is designed to give fundamental training in chemistry, physics, mathematics, and mineralogy as well as in ceramics. Although there is little specialization within ceramics, the trend is toward a study of the occurrence, properties, and utilization of nonmetallic minerals. The work in refractories is directed toward the selection and service conditions of refractories in metallurgical operations.

In line with the expansion program of the University, a considerable amount of new equipment has been installed in the ceramic laboratories. Some of the major items are (1) an additional petrographic microscope, making a total of four; (2) a Stormer viscosimeter; (3) a frit furnace with a Maxon Premix burner; (4) an automatically controlled Globar furnace; and (5) a Tinius Olsen transverse-strength machine. In addition, a large amount of money has been expended in purchasing back numbers of ceramic publications.

Student Branch

A Student Branch of The American Ceramic Society was installed in March with twenty charter members (see *The Bulletin*, May, 1940, p. 194).

Research Fellowship in Ceramics

Otto R. Stach, a member of the senior class at Rutgers University, has been appointed to the Research Fellowship in Ceramics for next year.

University of Illinois

Bachelor of Science, Dept. of Ceramic Engineering: W. T. BARTOW, Alton; A. C. BARZDUKAS, Rockford; J. R. BOEKER, Edwardsville; L. K. BREEZE, Decatur; J. W. BRISCOE, Westfield; V. J. CICHOWSKI, New Britain, Conn.; A. B. COSBY, Mayfield, Ky.; J. D. DAYTON, Champaign; L. M. DONEY, Streator (graduated in February, 1940); G. B. EYERLY, Canton; J. S. GREENBERG, Chicago; C. F.

HANKS, Bloomington; P. L. HUTTON, Rockford; H. C. JOHNSON, Nokomis (will be graduated at end of summer school, 1940); A. S. KARRER, Granite City; H. M. KILLMAR, Staunton; J. J. KRIVEC, South Standard; V. W. LENZ, Chicago; E. M. LOBDELL, Maywood; V. R. LUSTER, Vernon; D. O. MCCREIGHT, Plymouth; J. L. MORRIS, Champaign; M. M. MULLIS, Mansfield, Ohio (graduated in February, 1940); A. W. NUTT, Peekskill, N. Y.; R. A. OESTERLE, Belleville; A. C. OTTOSON, Bellaire, Ohio; J. R. RAWLINSON, Ford City, Pa.; G. C. RHODES, Urbana; A. H. ROBERTS, Brooklyn, N. Y.; R. C. STEIL, Des Plaines (graduated in February, 1940); H. R. SWIFT, Streator; W. F. THIEMAN, Peoria; M. S. THORSON, Braceville; J. H. VEALE, Urbana (will be graduated at end of summer school, 1940); J. J. WEBBER, Mt. Sterling; H. F. WEST, Lockport; and R. E. WOLFENSPERGER, Rockford.

With High Honors

A. C. OTTOSON and H. R. SWIFT.

With Honors

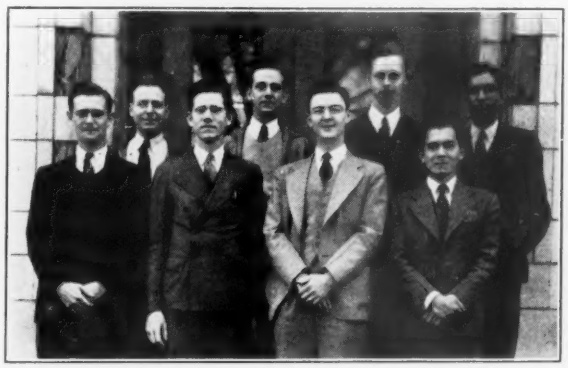
V. J. CICHOWSKI, J. R. BOEKER, and G. B. EYERLY.

Phi Kappa Phi

A. C. OTTOSON.

Tau Beta Pi

V. J. CICHOWSKI, J. R. BOEKER, G. B. EYERLY, A. C. OTTOSON, and H. R. SWIFT.

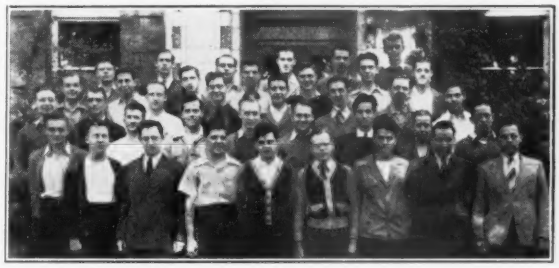


Graduate Students, Department of Ceramic Engineering, University of Illinois, 1940

Front row (left to right): (1) M. K. Blanchard, (2) A. R. Lesar, (3) T. L. Hurst, and (4) A. R. Rodriguez; *back row:* (5) P. E. Buckles, (6) W. E. Welliver, (7) V. D. Fréchette, and (8) A. K. Bhalla.

Harold Boeschenstein Outstanding Alumnus

Harold Boeschenstein, president of the Owens-Corning Fiberglas Corporation since its formation in November, 1938, has been chosen an outstanding alumnus of the College of Commerce and Business Administration of the University of Illinois. Mr. Boeschenstein is one of three graduates of the University to be honored this year. He was formerly vice-president and general manager of the Owens-Illinois Glass Company.



Senior Class, Department of Ceramic Engineering, University of Illinois, 1940

Front row (left to right): (1) H. C. Johnson, (2) R. A. Oesterle, (3) A. C. Ottoson, (4) R. G. Thomas, (5) V. R. Luster, (6) H. R. Swift, (7) T. Willmore, (8) J. R. Rawlinson, and (9) V. J. Cichowski; *second row:* (10) D. O. McCreight, (11) G. C. Rhodes, (12) C. F. Hanks, (13) V. W. Lenz, (14) W. F. Thieman, (15) A. H. Roberts, (16) M. S. Thorson, and (17) H. F. West; *third row:* (18) J. R. Zeller, (19) H. M. Killmar, (20) E. M. Lobdell, (21) W. T. Bartow, (22) A. B. Cosby, (23) P. K. Hutton, and (24) A. W. Nutt; *fourth row:* (25) J. D. Dayton, (26) A. S. Karrer, (27) L. K. Breeze, (28) J. J. Krivec, (29) T. E. Spires, (30) J. R. Boeker, and (31) A. C. Barzdukas; *fifth row:* (32) J. J. Webber, (33) J. L. Morris, (34) G. B. Eyerly, (35) J. H. Veale, (36) J. W. Briscoe, and (37) R. E. Wolfensperger.

Harold Boeschenstein, President, Owens-Corning Fiberglas Corporation

HONORS TO OUR MEMBERS

E. E. MARBAKER ON O. HOMMEL COMPANY FELLOWSHIP

The O. Hommel Company of Pittsburgh, Pa., has established a fellowship at Mellon Institute for the joint purpose of carrying on a broad program of scientific investigation and of maintaining contact with existing professional agencies. Edward E. Marbaker has received the appointment to this fellowship.

Dr. Marbaker was graduated as a chemist from the Towne Scientific School of the University of Pennsylvania in 1910 and four years later received his doctorate from the same institution. He was first employed by the Westinghouse Lamp Company at Bloomfield, N. J., where he con-

ducted investigations on the platinum metals, tungsten, and molybdenum; later he became chief chemist and had charge of the metallurgical laboratory. In 1917, he became associated with Alexander Brothers, Philadelphia, manufacturer of leather belting, as chief chemist and subsequently as chief engineer. In 1920, he was chief chemist

Edward E. Marbaker

for the Cleveland Wire Division of the National Lamp Works of the General Electric Company, specializing in problems in the manufacture of nonsag-tungsten wire and molybdenum metal.

For twenty years, Dr. Marbaker has been a fellow of Mellon Institute, engaged in research and development work in chemistry, ceramics, and metallurgy. Over a five-year period he carried out comprehensive investigations on the general improvement of the service life of clay retorts used in the smelting of zinc ores; this program involved the study of the properties of many refractory clays and resulted in the production of an efficient retort containing silicon carbide. Later he held a fellowship relating to the metallurgy of cast iron, the combustion engineering of the foundry cupola, and pertinent ceramic problems.

Dr. Marbaker has been a member of The American Ceramic Society since 1926.

C. FORREST TEFFT, ALFRED TRUSTEE

At the meeting of the Alfred University Corporation in connection with the meeting of the Board of Trustees, June 10, C. Forrest Tefft was elected a member of the Board of Trustees of the University. He will succeed the late Clarence W. Spicer.

Mr. Tefft has been Treasurer of The American Ceramic Society since 1937.

RECEPTION FOR L. E. BARRINGER

President J. L. Carruthers and members of the staff of The American Ceramic Society entertained at luncheon in the executive offices on June 11 in honor of L. E. Barringer, former president of The American Ceramic Society. Mr. Barringer was the recipient of the Lammé Medal presented at the Ohio State University convocation exercises held Monday evening, June 10.

PLAN YOUR VACATION TO INCLUDE THE 1940 AUTUMN DIVISION MEETINGS

Division	Place	Date
Art	(1) Blue Ridge, N. C.	July 29–August 4
	(2) Syracuse, N. Y.	October 12–13
	National Ceramic Exhibit	
Enamel Porcelain Enamel Institute Forum	University of Illinois	October 16–18
Glass	Hotel Hershey, Hershey, Pa.	September 6–7
Materials and Equipment and Whitewares	Summit Hotel, Uniontown, Pa.	September 13–14
Refractories	Summit Hotel, Uniontown, Pa.	September 6–7
Structural Clay Products with Structural Clay Products Institute	(Place not determined)	November 12–14
Institute of Ceramic Engineers with A.I.M.M.E.	Urbana, Ill.	November 14–15

HONORING RAY T. STULL

The 1940 *Illini Ceramist* is dedicated to Ray T. Stull, Chief of the Heavy Clay Products Division, National Bureau of Standards, Washington, D. C. Mr. Stull was the Head of the Ceramic Department of the University of Illinois from 1910 to 1915.

"An active leader of ceramic research—most instrumental in securing the erection of the building in which we are now located."

Ray T. Stull

This is the fourth annual issue of the *Illini Ceramist* published by the Illinois Student Branch of The American Ceramic Society. The threefold purpose of these "annuals" is to give a résumé of student activities within the Department of Ceramic Engineering, to present the graduating class of 1940, and to create the interest of graduates of secondary schools.

The 1938 issue was dedicated to Ross C. Purdy, General Secretary of The American Ceramic Society, and the first instructor in Ceramic Engineering at the University of Illinois. The 1939 issue was dedicated to Albert V. Bleininger of the Homer Laughlin China Company, who was the second instructor.

RESOLUTIONS OF APPRECIATION OF JOHN MILTON McKINLEY BY THE AMERICAN CERAMIC SOCIETY

John Milton McKinley served on the Board of Trustees of this Society for five years as Trustee representative of the Refractories Division, one year as Vice-President, one as President, and two years, ex officio Past-President, a total of nine consecutive years.

As Chairman of the Rules Committee, he harmonized the Constitution, By-Laws, and Rules of The Society with the present State of Ohio statutes on corporations.

He was active on several committees and contributed generously to the technical meeting programs.

He served diligently for eight years on the Board of Trustees of the Edward Orton, Jr., Ceramic Foundation as representative of The Society, the last two years as President of the Orton Board.

Always companionable and even-tempered, always generous in his council, and always interested in young men, his influence was uplifting and encouraging.

His diversity of interests and his many highly developed talents in music, fine arts, science, engineering, business, and economics resulted from perseverance, programed use of time, and discreet search for information.

His religious reverence and inspiring philosophy of human relations added to his charm. He was always tolerant of the beliefs of others.

By this Resolution, the Board of Trustees of The American Ceramic Society expresses its high regard for the services of John Milton McKinley and for his wholesome and inspiring fellowship which on the nineteenth day of May, 1940, was untimely terminated.

—*Board of Trustees, The American Ceramic Society*

A MESSAGE FROM OUR HONORARY MEMBER, ALFRED HERMAN MUNCH ANDREASEN

Laboratoriet for Mørtel, Glas og Keramik
Danmarks Tekniske Højskole
Copenhagen, Denmark
April 8, 1940

Will you accept my hearty thanks for your kind invitation to attend the Forty-Second Annual Meeting, which I received today.

If circumstances had permitted, it would have given me the greatest pleasure to attend. Due to delay in the mails, however, I have first received your letter today.

My experiences in the United States and especially the time spent with the American ceramists in 1937 still remain as one of the happiest events of my life and the *Journal of The American Ceramic Society* at present has become the best medium to me for following the development of my profession.

I wish I could make you feel how intensively we all in this country follow the development in the United States in order not to forget how a normal existence should be led.

EDWARD ORTON, JR., CERAMIC FOUNDATION FELLOWSHIPS

Five Fellowship appointments have been made by the Edward Orton, Jr., Ceramic Foundation for 1940–1941.

The Ohio State University: CHARLES B. TAUBER, "Influence of Kiln Atmosphere on Whiteware Fluxes."

The University of Illinois: H. C. THOMPSON, "Glaze Slip Control" (continuation).

The Pennsylvania State College: LANE MITCHELL, "Mineralogical and Colloidal Constitution of Certain Clay Types."

The New York State College of Ceramics: EVERETT THOMAS, "Effect of Glaze Penetration on Resistance of Porous Bodies to Crazing and Shivering."

Rutgers University: WILLIAM L. PESKIN, "Effect of Atmosphere on Qualities of Colors Produced in Colored Glazes of Several Types."

C. R. TENNANT TO TEACH CERAMICS AT WHITE SULPHUR SPRINGS

Charles R. Tennant, supervisor of Arts and Crafts of West Virginia, will replace H. Edward Winter in the Ceramic Department of the Old White Art Colony, White Sulphur Springs, West Virginia. Mr. Tennant, an experienced teacher, artist, and technician, received his ceramic training at the West Virginia University and at the New York State College of Ceramics, Alfred, N. Y.

ACTIVITIES OF THE SOCIETY

FELLOWS OF THE AMERICAN CERAMIC SOCIETY

Minutes of Annual Meeting

The annual meeting of the Fellows of The American Ceramic Society convened at 2:30 P.M., April 7, in the Ball Room of the Royal York Hotel in Toronto, Canada. Dean Samuel R. Scholes was the presiding officer.

The reading of the minutes of the last meeting was dispensed with, inasmuch as these were circulated among the Fellows.

Alexander Silverman, Chairman of the Committee on Honorary Membership, read the report of the Committee. It was moved by J. C. Hostetter, seconded by S. J. McDowell, and carried that Alfred Herman Munch Andreasen of Copenhagen, Denmark, be recommended to the Trustees for election to Honorary Membership in The American Ceramic Society. Carried.

The Secretary-Treasurer's report was read and accepted.

It was moved by J. W. Whittemore, seconded by C. E. Bales, and carried that any of the unexpended balance of the $50.00 previously appropriated to the Ceramic Educational Council be reappropriated for the coming year.

A. S. Watts made a motion, seconded by C. M. Dodd, that a sum not to exceed $300 be appropriated for a plaque to be placed in Orton Hall on the campus of Ohio State University to commemorate the founding of ceramic education in the United States in 1894. After some discussion, the motion was carried. The Chair appointed G. A. Bole and A. S. Watts as members of this committee with power to appoint a third member.

W. Keith McAfee moved and L. C. Hewitt seconded a motion that the Fellowship appoint a committee to consider the publication of a history of ceramic education in the United States to the present date, and if possible to initiate the writing of this history; motion carried. The Chair appointed R. C. Purdy as Chairman and L. E. Barringer and A. F. Greaves-Walker as members of this committee.

D. E. Sharp read the report of the Secretary-Treasurer, giving the results of the balloting for officers of the Fellows. Those elected were EDWARD SCHRAMM, *Dean;* T. A. KLINEFELTER, *Associate Dean;* and T. N. MCVAY, *Secretary-Treasurer;* G. W. MOREY was elected to Nominating Committee A, and A. V. BLEININGER to Nominating Committee B of The Society. W. Keith McAfee pointed out that the latter two nominations were in error, as the Fellowship has no representation on the nominating committees of The Society.

A motion was made and carried that the Rules of the Fellows concerning nominations and elections be changed to conform with the Rules of the general Society with the additional change that the Nominating Committee of the Fellows be reduced from five to three in numbers of members.

A motion to adjourn was made by J. W. Whittemore and seconded by Louis Navias.

—T. N. MCVAY, *Secretary-Treasurer,*
University of Alabama, University, Ala.

CERAMIC CAMERA CLUB

Notice to Members

Your new Board of Governors is as follows: E. L. HETTINGER, *Chairman;* JOHN R. HOSTETTER, IRWIN W. SCHOENINGER, JUNIUS F. KREHBIEL, and J. EARL FRAZIER, *Secretary-Treasurer.*

Be sure to see the new book by William Mortensen, called Outdoor Portraiture.

Let's get those new good photos *now* for Baltimore next year.

BALTIMORE-WASHINGTON SECTION

The annual summer meeting of the Baltimore-Washington Section was held on board the luxury yacht "Hattie," Saturday afternoon, June 1. Twenty members enjoyed the six and one-half hour cruise from the Baltimore harbor to the Magothy River and back.

The following officers were elected for 1940–1941:

Chairman: DONALD HUBBARD, National Bureau of Standards, Washington, D. C.

Vice-Chairman: KENNETH M. SMITH, Severn Clay Co., Baltimore, Md.

Secretary-Treasurer: D. G. MOORE, National Bureau of Standards, Washington, D. C.

Councillor: J. D. TETRICK, Baltimore Enamel & Novelty Co., Baltimore, Md.

—KENNETH M. SMITH, *Secretary-Treasurer*

NORTHERN CALIFORNIA

An illustrated talk on "Manufacture and Testing of High-Tension Insulators" by G. M. Whisler, plant superintendent of the Westinghouse Electric & Mfg. Co. at Emeryville, was the high point of the meeting of the Northern California Section in San Francisco on May 27. Thirty members in attendance at this last meeting before the summer recess also heard C. L. Barr, Superintendent of Safety Engineering of the State Compensation Fund, explain the Safety Contest being sponsored by the Section among the plants represented by its members. It is anticipated that ten plants will enter this contest, viz., California Art Tile Corp., California Pottery Co., N. Clark & Sons, Stockton Fire Brick Co., Gladding Brothers Mfg. Co., Kraftile Co., Myers Ceramic Products Co., Gladding, McBean, & Co., Emeryville Chemical Co., and Westinghouse Electric & Mfg. Co.

The contest starts June 1 and ends November 30, 1940. This Safety Contest, which is unique in ceramic Local Section activities, is aimed to create fun and fellowship among the representatives of the various plants as well as to improve the performance of each individual plant in this important phase of plant operation.

The Safety Contest Committee appointed by Chairman Chuck Kraft is Brad Wyatt, plant superintendent, N. Clark & Sons; Bill Hislop, plant superintendent, California Art Tile Corp.; and Frank Raine, Pittsburg plant, Stockton Fire Brick Co. This Committee will direct the conduct of the contest.

A report was also heard from Graham Smith of N. Clark & Sons, secretary and chairman of the Research Committee, with reference to progress on the proposed investigation of California's ceramic resources.

The visitors at this meeting included E. H. Fritz, ceramic engineer, Westinghouse Electric & Mfg. Co., Derry, Pa.; C. W. Fernholtz, Fernholtz Machinery Co., Los Angeles; and R. B. Carothers, H. C. Spinks Clay Co., Newport, Ky.

Meetings of the Section are held alternately in San Francisco and the East Bay.

The Section is sorry to report the loss of one of its most active members, E. E. Saunders, Vice-President of Gladding, McBean, & Co., who is being transferred to the Los Angeles office.

—C. W. KRAFT, *Chairman*

HERE IS A SERVICE OPPORTUNITY

Protecting Glass Against Blooming and Solubility

"We would appreciate it very much if you would send us a list of references of your publications pertaining to the use of sulfur and other agents for increasing the resistance of glassware to blooming and decreasing the solubility of the ware when in contact with various liquids."

Will members who have information on this subject please write it up.

CENTRAL OHIO SECTION

More than one hundred members and guests of the Central Ohio Section made a plant inspection trip through the Anchor Hocking Glass Corporation at Lancaster, Ohio, on the evening of June 19. Following the plant trip, dinner was served at the Hotel Lancaster.

The speaker of the evening was W. V. Fisher, vice-president of the Anchor Hocking Glass Corporation, whose subject was "History of Glass Manufacture in Lancaster."

This meeting was one of the most successful to be held by the Central Ohio Section and was the final meeting for this season. The officers of the Section are *Chairman*, C. J. KOENIG, Engineering Experiment Station, Ohio State University; and *Secretary*, M. C. SHAW, The Edward Orton, Jr., Ceramic Foundation.

COMMITTEES AND APPOINTMENTS FOR 1940–1941

A list of Standing Committees and Appointed Representatives for 1940–1941 was published in the May issue of *The Bulletin*, pages 184–85.

The following names were inadvertently omitted from this list.

On the Committee on Geological Surveys, the name of A. F. GREAVES-WALKER, Department of Ceramic Engineering, Univ. of North Carolina, Raleigh, N. C., should be added.

FREDERICK HEATH, JR., Colonial Clays, Inc., Worcester, Mass., has been appointed to the American Standards Association Sectional Committee A–62.

UNIVERSITY OF WASHINGTON

Another summer has rolled around, and with the last final examination squared away on Friday, June 7, 1940, the academic year of 1939–1940 at the University of Washington has come to a close. The year, in review, has been exceptionally interesting and successful for the ceramic engineers.

In the last few months, numerous activities at the College of Mines are deserving of mention. On May 22, 1940, John Richter of the Boeing Aircraft Co. lectured to the Student Branch on the inspection of airplane parts by the Magno Flux method.

Several weeks ago, an entire day was devoted to the photographing of the various outstanding phases of the ceramic industry. This movie, after final cutting, will run for approximately one-half hour and will be devoted to advertising the different colleges at the University of Washington.

Concerning employment and summer jobs, both the graduating seniors and underclassmen are, to a man, all lined up. Ben Davies will be working for the Pacific Pottery Company; Harry Luther for the Superior Portland Cement Company; Ken McBreen will be going a long way from home to Standard Sanitary at Richmond, Calif., and Jim McKinnell will be at the Pacific Stoneware Company in Portland, Oregon.

During the month of May, several field trips to various ceramic establishments in the vicinity of Seattle were conducted under the leadership of Carl H. Zwermann. Included in the plants visited were the Northwestern Glass Company and the Superior Portland Cement. During the latter part of May, an interesting tour was conducted through the Gladding, McBean, & Company at Renton, Wash., under the guidance of Howard Mansur, assistant superintendent.

Immediately following the close of school, Dr. Zwermann, Wendell Keith, Ken McBreen, and Vernon Moss left for eastern Washington on a field trip to the various plants and clay pits of this vicinity.

It is sincerely hoped that we, as a student body, may show our appreciation of many hours of patient instruction by applying ourselves in commendable fashion while in the field this summer.

—JIM MCKINNELL, *Student Secretary*

ST. LOUIS SECTION

A meeting of the St. Louis Section of The American Ceramic Society was held at the Little Bevo Restaurant in St. Louis on June 12, 1940, with about fifty persons in attendance.

After dinner, Chairman Paul Herold called on K. Aderholt for the Treasurer's report, which was accepted. Following a short business meeting, a program of papers was presented.

(1) "A Study of the Refractory Properties of Topaz," by R. S. BRADLEY and F. W. SCHROEDER, A. P. Green Fire Brick Co. (accompanied by lantern slides).

(2) "Properties of Alumina Refractories Bonded with Lumnite Cement," by J. L. HOFFMAN, Missouri School of Mines, Rolla, Mo.

(3) "Weatherproofing of Kiln Crowns," by L. A. KIMBERLING, Blackmer-Post Pipe Co.

—A. J. PAUL, *Secretary*

NEW MEMBERS FOR JUNE

Corporation

ADAMSTON FLAT GLASS CO., Box 631, Clarksburg, W. Va.

*CONSOLIDATED FELDSPAR CORP., M. J. McHugh, Jr. (voter), 1403 Trenton Trust Bldg., Trenton, N. J.

STUPAKOFF LABORATORIES, INC., S. H. Stupakoff (voter), 6617–27 Hamilton Ave., Pittsburgh, Pa. (formerly in name of S. H. Stupakoff, personal member).

Personal

HIRSSIG, CARL F., 4554 Westway, Toledo, Ohio; special representative, National Lime and Stone Co., Findlay, Ohio.

*KREGER, JOHN M., 123 Prospect St., Woodbridge, N. J.; ceramic engineer, M. D. Valentine & Brother Co.

NEWTON, ROBERT L., 3485 Bosworth Rd., Cleveland, Ohio; Owens-Illinois Glass Co.

THOMPSON, FRANKLIN S., 8 Columbia Ave., Milltown, N. J.; ceramist, New Jersey Clay Products.

Student

Iowa State College: O. J. WHITTEMORE, JR.

New York State College of Ceramics: DAVID L. ARMANT, FREDERICK A. LOUGHRIDGE, and EVERETT A. THOMAS.

Ohio State University: HARRY PAPIER.

Virginia Polytechnic Institute: MAURICE A. MURRAY.

University of Washington: KENNETH L. MCBREEN.

MEMBERSHIP WORKERS' RECORD

Corporation

W. A. Weldon	2	Office	1

Personal

G. H. Brown	1	L. G. Love	1
J. L. Carruthers	2		

Student

R. M. Campbell	3	C. H. Zwermann	1
C. M. Dodd	1	Office	1
J. W. Whittemore	1		
		Grand Total	**14**

ROSTER CHANGES DURING JUNE †

Personal

DAMMANN, ARTHUR, Box 502, Amityville, N. Y. (Brockway, Pa.)

GREENE, KENNETH T., Box 137, Alfred, N. Y. (New Brunswick, N. J.)

HAYNES, JACK C., 2 S. Clinton Ave., Trenton, N. J. (Maryville, Tenn.)

KURZ, WALTHER, Merry Oaks, N. C. (Perth Amboy, N. J.)

PAXTON, E. W., Mississippi Glass Co., Main & Angelica Sts., St. Louis, Mo. (Washington, Pa.)

RIEGGER, HAROLD E., Alfred, N. Y. (Philadelphia, Pa.)

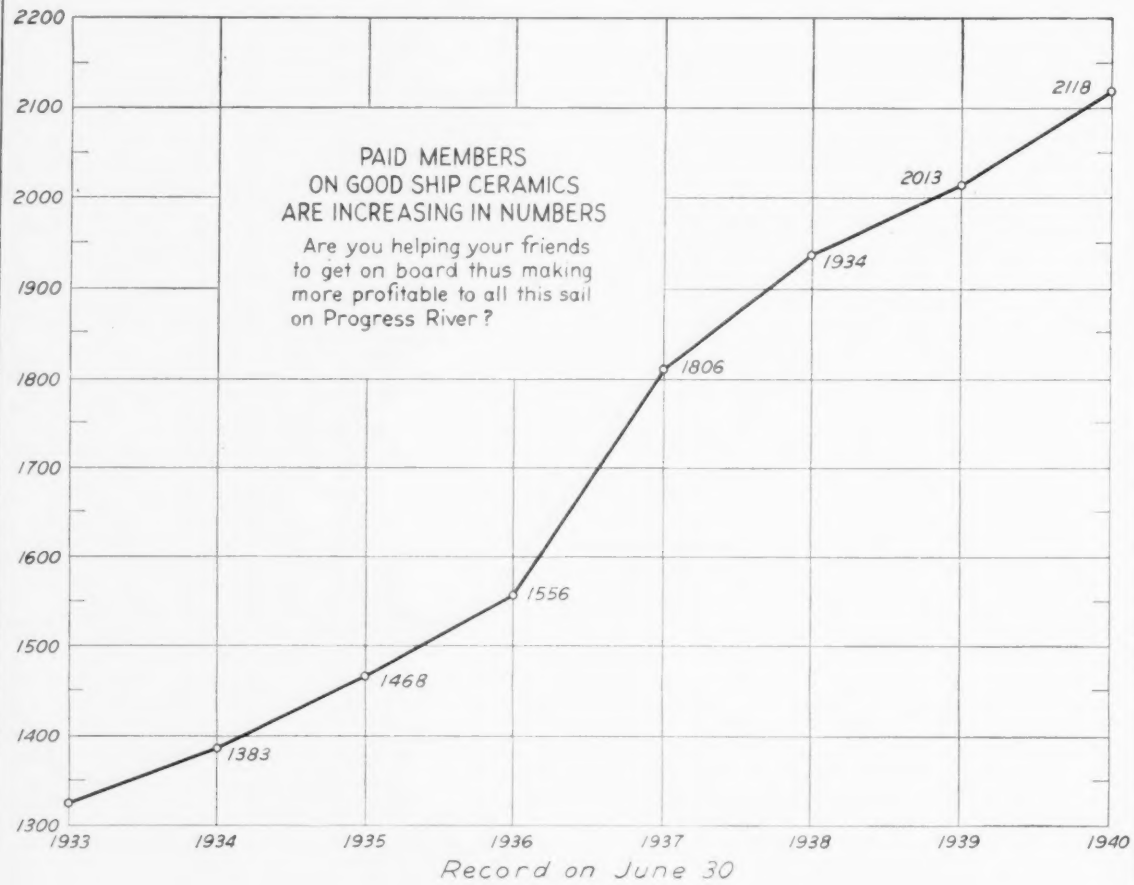
* Indicates former member of The Society rejoining.
† Address in parentheses is former address.

W W W
H H H
Y Y Y

WHY are personal and corporate ceramists joining together to promote the arts, science, and technology of ceramics?

WHY should the 2118 shown in this chart voluntarily expend time, thought, and money on this joint enterprise?

WHY should there be this annual increase in numbers of ceramic investors?



Paid Membership Record

Date of Record	Members paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
	Personal	Corporation				
January 22, 1940	1930	244	23	656	220	3073
February 20, 1940	1972	243	30	669	220	3134
April 17, 1940	1724	241	30	522	220	2737
May 21, 1940	1801	247	27	552	220	2847
June 19, 1940	1839	251	28	556	220	2894

"It pays" is the evident answer to each of these "WHY'S."

WHY ANNUAL MEETING REGISTRATION FEES

After years of experience, study, and trials of various schemes, the Board of Trustees of The American Ceramic Society has adopted the policy of financing all Annual Meeting expenses from registration fees.

The cost of building and operating the Annual Meeting programs has always been financed by The Society.

The cost of entertainment at the Meetings for several years was paid by the Local Committees. This was an imposition.

Meetings Must Be Financed

The Society would lose its status with the several federal and state taxing agencies as strictly a scientific, technical, and educational organization should it finance any portion of its Meeting expenses by holding commercial exhibits.

To finance the Meetings out of the general funds would mean (1) making all members of The Society pay for the advantages enjoyed only by those who attend, (2) making Meeting privileges available without cost to a lot of persons who are not members, and (3) using the money for Meetings that presumably is to be expended only for publications and for operating The Society.

In twenty years, the net loss totals $15,035.24, or $717.63 per Meeting.

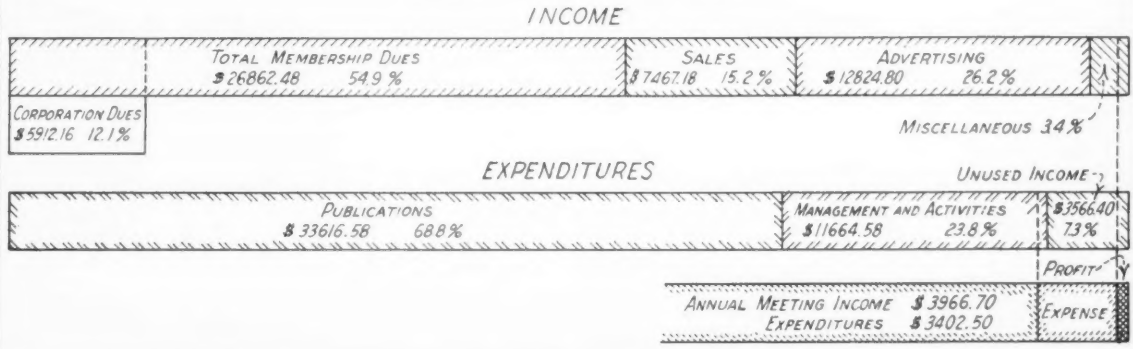
Meeting together, working together, and communing together make for personal and industrial progress. These are reasons why Meetings are held. The research reports obtained would not alone justify the holding of Meetings, for these could be obtained in other ways with much less effort and expense.

The most generally satisfactory and certainly the most practical scheme is to finance the Meetings exclusively by registration fees, viz., $5.00 for delegates, $1.50 for students, and $1.00 for women.

The Profit and Loss Statements for several Meetings are as follows:

Date	Place	Profit	Loss
1921	Columbus		$1667.27
1922	St. Louis		1301.26
1923	Pittsburgh		1455.17
1924	Atlantic City		1522.40
1925	Columbus		2470.45
1926	Atlanta		1410.28
1927	Detroit		2078.49
1928	Atlantic City		1276.83
1929	Chicago	$143.04	
1930	Toronto		798.44
1931	Cleveland	666.90	
1932	Washington, D. C.		873.24
1933	Pittsburgh	125.21	
1934	Cincinnati		160.00
1935	Buffalo	460.16	
1936	Columbus		365.92
1937	New York		439.03
1938	New Orleans		1286.00
1939	Chicago	554.44	
1940	Toronto	119.79	
		$2069.54	$17,104.78

Here, Graphically, Is Your 1939 Financial Statement Based on Total Income



FORTY-THIRD ANNUAL MEETING, THE AMERICAN CERAMIC SOCIETY

BALTIMORE, MARYLAND, MARCH 30 to APRIL 5, 1941

Headquarters and Meetings in Lord Baltimore Hotel
With Guaranteed Rooms Available in Hotels Emerson, Southern, Maryland, New Howard, and Belvedere

LINCOLN T. WORK TO DIRECT RESEARCH FOR METAL & THERMIT

Lincoln T. Work, associate professor of chemical engineering at Columbia University, has been appointed director of research of the Metal & Thermit Corporation, New York, N. Y.

Since July 1, 1940, all of the research and development activities of this Corporation, including work in electric arc and thermit welding, pigments, metals and alloys, and various phases of chemical and metallurgical engineering, have been under his supervision.

Dr. Work was born in Hartford, Conn., was graduated from Columbia University in 1918, and received his degree of Doctor of Philosophy from there in 1929. He has been successively instructor, assistant professor, and associate professor of chemical engineering at Columbia, where he helped to create and establish a process development course, supervised chemical-engineering thesis projects for the Doctorate, organized and directed a course in chemical-engineering principles for men in industry, and served as assistant to the director of extension teaching and to the dean of engineering in charge of the engineering school Men in Industry Program.

In addition, Dr. Work has conducted research for a number of industrial concerns in the cement and clay, paint and varnish, air conditioning, plastics, pulp and paper, and pulverized coal fields, and has organized a division of fundamental research for one of the country's largest corporations in the chemical-engineering industry.

Dr. Work is a member of a number of honorary fraternities and professional societies, including the American Institute of Mining and Metallurgical Engineers, the Electrochemical Society, the American Institute of Chemical Engineers, the American Chemical Society, the Society of Chemical Industry, and the American Society for Testing Materials, in many of which he has held various offices and has done committee work. He also is a member of several committees of the National Research Council and the American Standards Association. The American Section of the Society of Chemical Industry has elected him as its chairman for the coming year. He is also the author of a number of publications on chemical-engineering subjects.

Dr. Work's paper on "Factors Influencing Particle Size and Shape in Grinding" was published in *The Bulletin of The American Ceramic Society*, **17** [1] 1–5 (1938). He has been a member of this Society since 1937.

LAURA A. FRY ADDS HISTORICAL PIECES TO CERAMIC EXHIBIT

The ceramic exhibit at the executive offices of The Society is growing in size and value. Many historical pieces, especially from Cincinnati, are preserved here.

Miss Fry has recently given three additional pieces, each made by her. Miss Fry, who is now in her eighty-fourth year, lives in Terrace Park, Ohio. (For story of Miss Fry, see *The Bulletin*, **17**, [9] 368–72 (1938).)

(1) Red clay vase etched and curved; sagger glaze (called "smear"); date, 1881.

(2) China plate, overglaze; first lesson in china painting given Miss Fry by Miss Mary Louise McLaughlin; July, 1878.

(3) Cup and saucer, blue and gold raised paste design; first piece done for the Porcelain League first monthly meeting.

The last two items are the gift of Mr. and Mrs. Hereward Fry, Camp Dennison, Ohio. The vase is the gift of L. Elsa Loebes, New York, N. Y.

MISS COOK IS HONORED

Miss Mary Elizabeth Cook, of Columbus, Ohio, a member of The American Ceramic Society, on April 29 was presented with a life membership in the Columbus branch of the National League of American Pen Women.

Lincoln T. Work

L. E. BARRINGER ON ORTON FOUNDATION BOARD

Lawrence E. Barringer, of the General Electric Company, Schenectady, N. Y., has been unanimously elected by the Trustees of The American Ceramic Society to serve on the Board of Trustees of the Edward Orton, Jr., Ceramic Foundation. Mr. Barringer will succeed John Milton McKinley, whose death occurred on May 19, 1940.

NECROLOGY

WILLIAM A. HARSHAW

William Andrew Harshaw, chairman of the board of the Harshaw Chemical Company, Cleveland, died on June 4 at his estate in Gates Mills after a prolonged illness. He was seventy-eight years of age.

A native of Dodgeville, Ia., Mr. Harshaw began his business career with the Meyer Brothers Drug Company, Kansas City, in 1881, with which organization he remained until 1884, when he joined the Lord Owens & Co., wholesale druggist, in Chicago. Five years later he went to Cleveland to join Strong, Cobb & Co., to take charge of its chemical sales department. After three years with the Strong, Cobb organization, Mr. Harshaw entered business on his own account, forming the Cleveland Commercial Company, chemical merchants and brokers. In 1893, Ralph L. Fuller was taken into the business; and in 1895, Wallace B. Goodwin became a member of the firm, which reorganized in 1898 as the Harshaw, Fuller & Goodwin Company.

Mr. Harshaw served as president of the Harshaw, Fuller & Goodwin organization from 1898 to 1924 and chairman of the board until 1929, when the name became The Harshaw Chemical Co. He was president of this company until 1936, when he became chairman of the directorate.

Mr. Harshaw was a trustee of the Case School of Applied Science, a member of the American Chemical Society, and the Chemists' Club of New York. Surviving are his widow, three daughters, and two sons, J. A., Washington, D. C., and W. J., who succeeded his father in the Harshaw presidency.

A. M. GREAVES-WALKER

Mr. Greaves-Walker lost his life in the railroad disaster of the New York Central Lake Shore Limited on April 19 (see *The Bulletin*, May, p. 196). The Libbey-Owens-Ford plant publication, *The Batch*, makes the following statement about his work with this Company:

"As Ceramic Engineer in the Specialties and Development Department, 'Mac' helped in the development of several Libbey-Owens-Ford products. He was largely responsible for the present molds used in the automotive heat-treating process—a process which is considered to be a major step forward in the industry.

Arthur McKinley Greaves-Walker, 1907–1940

"Most of the technical work in the development of Thermolux was placed in his hands. For several years he had a major part in developing an improved method of manufacturing glass pots. He contributed greatly to the conception and development of Vitrolux. He designed and supervised the construction of many of our bending furnaces and consistently helped to solve the problems of glass bending.

"Much of his time was spent in tireless study and investigation of refractory materials used in pots and furnaces, spurred on by an eagerness to gain all the knowledge he could in his field. His endless patience with the technical problems he met almost daily was combined with his natural ability to make his work invaluable.

"'Mac's' imaginative and industrious application of his knowledge and experience meant much in the development of Libbey-Owens-Ford products—and productive efficiency. As a technician he will be sorely missed. Our loss of him as a friend cannot be adequately expressed."

J. H. CAVENDER

John H. Cavender, vice-president and director of the North American Refractories Company, Cleveland, Ohio, since 1929, died of a heart ailment on May 29, 1940, in Cleveland Heights, Ohio, at the age of fifty-six.

Mr. Cavender was born October 8, 1883, in Connellsville, Pa. He entered the refractories industry in 1904, when he became associated with the Harbison-Walker Refractories Company as correspondent and salesman. He remained with this Company until 1907, when he became sales manager with the American Refractories Company of Chicago. In 1915, he was associated with the Chicago Retort and Fire Brick Company as vice-president. From 1926 to 1929, Mr. Cavender was vice-president of the Dover Fire Brick Company, which Company, in 1929, merged with others to form the North American Refractories Company.

Mr. Cavender was also the first treasurer and a former president of the Refractories Manufacturers Association, now known as the American Refractories Institute.

He was a member of the American Iron and Steel Institute and the Union League Club of Chicago.

Mr. Cavender is survived by his widow, a son, and three daughters.

J. H. Cavender

Forward-going aggressive ceramists succeed only by continuous studying, not narrowly, but broadly the current problems in all ceramic fields.

NOTES AND NEWS

A. W. WEBER AWARDED SLOAN FELLOWSHIP

Arthur W. Weber, assistant manager of the Wellsboro Division of Corning Glass Works, Corning, N. Y., is among eleven young industrial executives awarded Alfred P. Sloan Foundation Fellowships for a special one-year program of advanced study at Massachusetts Institute of Technology. The winners were chosen from representatives of 279 companies who were entered in the competition. The program in business administration and economics "aims further to prepare, for ultimate positions of higher administrative responsibility, young executives of seasoned intellectual capacity, proved managerial ability, and demonstrated sensitiveness to the social and civic implications of industry." The Fellowship program is made possible largely through a grant of funds from the Alfred P. Sloan Foundation.

Arthur W. Weber, Assistant Manager, Wellsboro Division, Corning Glass Works

Arthur W. Weber, who is thirty years old, was born in Brooklyn, N. Y., and attended Yale University where he was graduated in 1933 with the degree of Bachelor of Science in Mechanical Engineering.

GLASS SHOWS OFF JEWELS

The costume and precious jewels on display in the windows of Richter's jewelry store on Fifth Avenue, New York, sparkle behind this modern storefront dress, which was remodeled by Telchin and Gina, a New York architectural firm. Richter's is one of the first examples of the beauty and practicability of the new satin-finish vitrolite structural glass. This new material, in soft gray, is complemented by the polished plate-glass show windows and the large panel of translucent patterned glass which lights the second floor. A feature of this design is the six-inch radius curve on the right-hand window, which extends upward to the vitrolite reveal above the bronze awning box.

The natural resistance of structural glass to acid in the atmosphere is playing an important part in the increasing popularity of this material for store fronts.

Satin-finish vitrolite structural glass

NINTH NATIONAL CERAMIC EXHIBITION AT THE SYRACUSE MUSEUM

Preview-Reception, Saturday Evening, October 12, Syracuse, N. Y.

The Second Ceramic Forum will be held on Sunday, October 13.

The first Forum, held last year and attended by artists and visitors from many states, was so successful and so stimulating that it has been voted to make it an annual feature.

"Come for a Ceramic Week-End"

REFRACTORIES INVESTIGATIONS

Mellon Institute has issued a new pamphlet, entitled "Refractories Investigations in Mellon Institute," which gives a brief history of the Refractories Fellowship and a description of test work and the researches conducted, with twenty full-page photographs of installations of the apparatus used.

Copies of this pamphlet will be sent gratis to all readers of *The Bulletin of The American Ceramic Society* who request them.

What outstanding design has greatly advanced the art of glass melting?

THE SIMPLEX INTERLOCKING SUSPENDED BACKWALL AND COVERED DOGHOUSE FOR TANKS

What this design will do for you as a glass manufacturer:

1. Reduces dust at the charging end.
2. Reduces cost of mantel block replacement.
3. Causes batch to frit before being exposed to flame.
4. Eliminates large percentage of dust and prolongs life and efficiency of checkers.
5. Gives greater flame coverage which produces more efficient melting.
6. Increases life of refractories in upper structure due to less dusting.
7. Gives better control of the foam line.
8. Melts same tonnage with less fuel than is possible with conventional method of filling.

Simplex Engineers will gladly give you evidence of five years of successful operations with this design. When shall you want to see a Simplex representative?

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Carborundum Co. (*Carborundum and Aloxite*)
Celo Mines, Inc. (*Almanite Garnet*)
The Hommel Co., O., Inc.
Norton Co. (*Alundum-Crystolon*)

Air Conditioning Systems
Frazier-Simplex, Inc.

Aloxite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
The Vitro Mfg. Co.

Alumina (Fused) Brick and Tile
The Vitro Mfg. Co.

Aluminum Oxide (Calcine)
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Aluminum Oxide (Fused)
Carborundum Co.
Harshaw Chemical Co.
Norton Co.
The Vitro Mfg. Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bicarbonate
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Solvay Sales Corp.

Ammonium Bifluoride
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Ammonium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Antimony Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Antimony Sulphide
Edgar Plastic Kaolin Co.
Foote Mineral Co.
The Hommel Co., O., Inc.

Arches (Interlocking, Suspending, and Circular)
Frazier-Simplex, Inc.

Arsenic
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.

Automatic Brick Car Loaders
Lancaster Iron Works, Inc.

Ball Mills
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
McDanel Refractory Porcelain Co.
The Vitro Mfg. Co.

Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Vitro Mfg. Co.

Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Foote Mineral Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Basic Oxides
Porcelain Enamel and Mfg. Co.

Batch Systems
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
National Engineering Co.

Batts
Carborundum Co. (*"Carbofrax Aloxite"*)
Denver Fire Clay Co.
Norton Co. (*Alundum-Crystolon*)

Beryl
Foote Mineral Co.

Bichromate of Soda
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Bitstone
Potters Supply Co.

Blocks (Refractory)
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Louthan Mfg. Co.
Norton Co.
The Vitro Mfg. Co.

Body Stains
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Bone Ash
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Borax
American Potash & Chemical Corp.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Borax Glass
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boric Acid (Anhydrous)
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boric Acid (Crystal, Granular, or Powder)
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boron Carbide
Norton Co.

Brick Machines (also Barrows, Molds)
Lancaster Iron Works, Inc.

Brick (Refractory)
Carborundum Co. (*"Carbofrax Aloxite"*)
Corhart Refractories Co.
Denver Fire Clay Co.
Norton Co.
The Vitro Mfg. Co.

Cadmium Sulphide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Carbofrax (Refractory Products)
Carborundum Co.

Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Castings
Lancaster Iron Works, Inc.

Castings (Abrasive Resisting)
Bethlehem Steel Co.

Caustic Potash
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Solvay Sales Corp.

Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Cements
Carborundum Co.
Corhart Refractories Co.
Norton Co.
Pennsylvania Salt Mfg. Co.

Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
Edgar Plastic Kaolin Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Cerium Oxide
Drakenfeld, B. F., & Co.
Foote Mineral Co.

Chromite (Natural Chromate of Iron)
Foote Mineral Co.

Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay (Bentonite)
Edgar Plastic Kaolin Co.
Great Lakes Foundry Sand Co.

Clay (Block)
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Clay (China)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Thomas Alabama Kaolin Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay—Cleaners, Feeders
Lancaster Iron Works, Inc.

Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Metal & Thermit Corp.
Paper Makers Importing Co.
Porcelain Enamel and Mfg. Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay (Fire)
Denver Fire Clay Co.
Great Lakes Foundry Sand Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

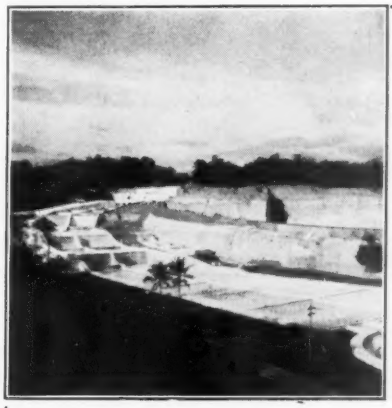
Clay (German Vallendar)
Ceramic Color & Chemical Mfg. Co.

POSITION WANTED—Ceramic engineer, 33, with an eight-year successful record in burning and supervision in the manufacture of quality products desires an Eastern location. Interested in an aggressive concern with field for development. Excellent references. Address Box 185F, American Ceramic Society, 225 N. High St., Columbus, Ohio.

Wanted to Buy

September 1925
Journal, Part II

American Ceramic Society
2525 N. High St. Columbus, Ohio



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AND
DRAINAGE PIPES

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We Manufacture—
Pins—all shapes and lengths
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We Sell—
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Sagger Clays—Kentucky
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Modeling Clay

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KAMEC

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TABLE OF ELAPSED TIME BETWEEN BALTIMORE AND PRINCIPAL CITIES IN UNITED STATES AND CANADA

	By rail		By air		Driving mileage
	Hr.	Min.	Hr.	Min.	
Atlanta, Ga.	17		4		728
Boston, Mass.	8	45	2	50	413
Buffalo, N. Y.	10	30	3	15	378
Charleston, S. C.	12		3	45	567
Chicago, Ill.	15	45	4	30	691
Cincinnati, Ohio	15	15	2	50	500
Cleveland, Ohio	15	45	2	50	362
Dallas, Texas	36	45	7	50	1468
Denver, Colo.	32		9	50	1726
Detroit, Mich.	15	30	4	45	527
Kansas City, Mo.	29		7	50	1064
Los Angeles, Calif.	56		15	30	2957
Memphis, Tenn.	25	30	5	30	977
Minneapolis, Minn.	23		7	40	1134
Montreal, Que.	15	30	5	30	573
New Orleans, La.	33		8	30	1259
New York, N. Y.	3	15	1	30	188
Norfolk, Va.	Overnight by boat				230
Oklahoma City, Okla.	34		10		1467
Omaha, Neb.	26		8		1161
Philadelphia, Pa.	1	45		40	100
Pittsburgh, Pa.	7	30	1	40	232
Richmond, Va.	4		1	25	148
Salt Lake City, Utah	43		13	30	2281
San Francisco, Calif.	58		15	45	3069
Seattle, Wash.	64		21		3001
St. Louis, Mo.	20	45	5	40	811
Toronto, Ont.	14		5	15	493
Washington, D. C.		45		15	37

See page 265 for Baltimore Museum of Art story

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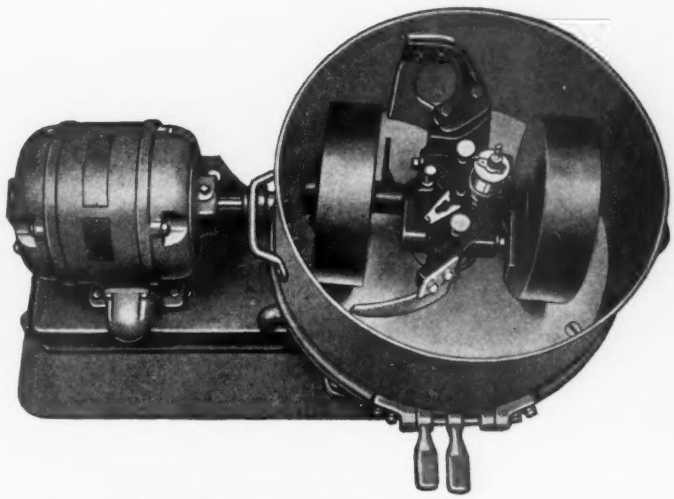

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